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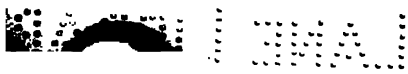

PREFACE TO FIRST EDITION.

A recognition of the necessity of making a correct diagnosis before instituting treatment has prompted me to write this treatise. I have omitted the diagnosis of affections of the eye, ear, nose, throat, and skin, since these are so fully considered in the special treatises upon these subjects. The only exceptions are the intracranial complications of middle ear and mastoid disease and those affections of the upper respiratory tract which require major surgical intervention.

The question of diagnosis has been approached chiefly from the clinical standpoint. An attempt has been made to group injuries and diseases in the manner in which the surgeon or general practitioner must consider them when he examines a patient for the purpose of making a diagnosis. Thus, in the chapter upon injuries of the head, the various traumatic lesions of the scalp, skull, and brain are considered together. In the chapter upon the abdomen the injuries of all of the abdominal viscera are taken up in a similar manner.

The division of diseases of the abdomen into acute abdominal affections, abdominal tumors, and a further description of the remaining surgical conditions of the abdominal viscera, may occasion some criticism. In making such an apparently arbitrary classification I have had in mind the clinical picture as one encounters it at the bedside. Although such divisions are not appropriate for a text-book which includes pathology and treatment, they seem most practical for a book limited to diagnosis.

The same principle has been applied throughout. The importance of differentiation of affections which simulate each other has been constantly borne in mind, repetition being avoided as much as possible. The necessity of making a diagnosis at an early period for the purpose of instituting prompt surgical intervention, is frequently referred to. Much attention has been paid to the description of methods of examination, and this has been aided wherever possible by illustrations.

Being a strong advocate of the teaching of surgery by the education of the eye, I have introduced a large number of original illustrations of clinical cases and specimens. I am indebted to my colleagues upon the staffs of the Cook County and Michael Reese Hospitals for the privilege

of photographing many of their patients. I desire to thank Drs. M. L. Blatt and F. Baumann for valuable suggestions. The section upon methods of blood examination was written by Dr. D. L. Schram. The section upon cystoscopy and ureteral catheterization was written by Dr. Gustav Kolischer.

DANIEL N. EISENDRATH.

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SURGICAL DIAGNOSIS.

CHAPTER I.

SURGICAL AFFECTIONS OF THE HEAD.

INJURIES OF THE SCALP, SKULL, AND BRAIN.

For clinical purposes the scalp can be considered as composed of three layers (Fig. 1), viz., the outer or cutaneo-aponeurotic, the middle or subaponeurotic, and the inner or pericranial. In infants the last-named layer or pericranium is loosely attached to the skull, except along the sutures, while in the adult it is so firmly attached over the entire vertex that it can only be torn off with difficulty. In examining a recently injured person in order to make a diagnosis of the nature and gravity of an injury to the head, one must systematically consider in the order named: (1) Injuries of the scalp. (2) Injuries of the skull. (3) Injuries of the various intracranial structures. Suppose, for example, that one is called to a patient who has fallen upon his head. One must first examine: (*a*) The nature of the scalp injury, whether the wound is penetrating and how deep, or if only a contusion is present. (*b*) The nature of the skull injury, whether of the vertex alone or base alone, or of the vertex extending into the base or vice versâ. What is the exact character of the fracture—fissured, depressed, comminuted, punctured, etc.? (*c*) Are symptoms present of cerebral injury (contusion, concussion, and compression) or of laceration of the meningeal vessels or endocranial sinuses? (*d*) Then after the first twenty-four to forty-eight hours, the question of infection and of cerebral edema arise. If the case progresses favorably, the question of the presence or absence of certain sequelæ of head injury as discussed on page 69 present themselves. The various forms of injury are considered in the following pages as they must occur to the mind of the physician or surgeon in attempting to make a diagnosis of the case before him.

INJURIES OF THE SCALP.

These occur either in the form (*a*) of penetrating, *i. e.*, incised or punctured wounds, which may penetrate one or more of the layers, or

(*b*) appear as contusions with swelling of these layers caused by extravasation of blood, or (*c*) the two forms may be combined. All scalp wounds are more or less lacerated.

These occur either in the form (*a*) of penetrating, *i. e.*, lacerated, incised, or punctured wounds, which may penetrate one or more of the layers, or (*b*) appear as contusions with swelling of these layers caused by extravasation of blood, or (*c*) the two forms may be combined.

Penetrating Wounds.—The diagnosis of these is readily made by inspection, which should be preceded by shaving the scalp for a distance of at least three inches from the edges of the wound. The chief point of interest is to ascertain whether they simply extend (*a*) through the skin and subcutaneous tissue, or (*b*) through the aponeurosis.

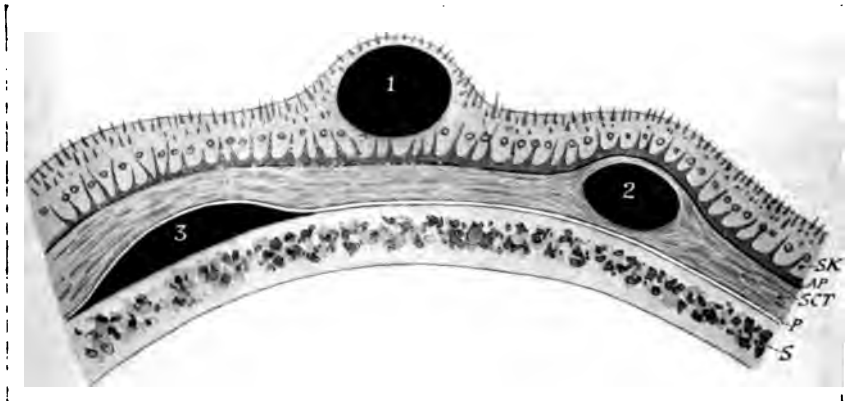

FIG. 1.—LOCATION OF VARIOUS HEMORRHAGES IN THE SCALP.

SK and *AP* represent the cutaneo-aponeurotic layer; *P* pericranium; *S*, skull; *S C T*, subaponeurotic connective tissue; 1, superficial hematoma or contusion in skin proper of scalp; 2, hemorrhage in subaponeurotic layer; 3, subpericranial hemorrhage. The latter is the location of the hemorrhage in the cephalhematoma of infants.

Wounds of the former class never gape, while in those of the latter class the edges separate. Retraction of the edges will enable one to determine whether the wound also involves the pericranium and skull. It cannot be too strongly emphasized that the greatest care should be exercised to render aseptic not only the scalp itself, but also the hands of the examiner and the instruments to be employed, before an exploration of the depth and possible complications of a scalp wound are begun. Injury of the larger arteries of the scalp can be suspected when the hemorrhage is profuse and of a spurting character, especially when the wounds are situated close to the frontal, temporal, or occipital arteries.

Contused Wounds of the Scalp.—The diagnosis of these must

be made from a consideration of the age, the history and the local findings. There are three possible locations for contusions of the scalp: (*a*) Superficial contusion. The hemorrhage takes place into the subcutaneous layer. There is only slight discoloration and swelling. The swelling follows the movements of the scalp. (*b*) Subaponeurotic. The area of hemorrhage is larger and the swelling is quite apparent. The edge is usually firmer than the center, and the first impression gained upon palpating the scalp is that a depressed fracture is present. The differentiation of these two conditions is considered on page 21. (*c*) Subpericranial. This form of contusion is seldom recognizable in adults unless it accompanies a scalp wound or a fracture, owing to the fact that in the adult, the pericranium is firmly attached to the skull over the entire convexity. In the newborn, subpericranial extravasations are quite common, especially after prolonged labor, where considerable pressure has been exerted upon the head by instruments or by the bony pelvis. Such swellings are called *cephalhematomata*, and are the result of an extravasation of blood between the pericranium and the skull (Fig. 1). The pericranium in infants is loosely attached except along the sutures; hence the diagnostic features are: that these cephalhematomata are situated over one or both parietal bones (Fig. 2), and terminate at the sutures (either coronal, sagittal, or lambdoidal). They fluctuate, but do not increase in size when the child cries. The absence of the latter feature in cephalhematomata and the fact that meningoceles almost always occur in the frontal or the occipital region, enable one to differentiate these two conditions in the scalp of infants. At a later period (four to six weeks after birth) a zone of ossification often begins at the edge of a cephalhematoma, and in [redacted] the history, a fracture might

FIG. 2.—CEPHALHEMATOMATA OF NEWBORN CHILD.
1, Hematoma over right parietal bone; 2, hematoma over left parietal bone.

be thought of. The limitation of the swelling by the sutures, the distinct fluctuation to be obtained, and the fact that pressure does not reveal any defect in the skull or cause any cerebral symptoms, enable one to exclude a meningocele or a depressed fracture.

A cephalhematoma may occur without the history of injury in scorbutic and rachitic children and be mistaken for an abscess following tuberculosis of the cranial bones.

Special Forms of Scalp Injury.—It would seem advisable in connection with the subject of contusions of the scalp to call attention to a swelling which may produce a considerable elevation of the overlying intact scalp. This swelling follows an injury to the scalp and skull and is called *traumatic cephalhydrocele* (Fig. 3) or *meningocele spuria traumatica*. The injury may have been accompanied by symptoms of cerebral concussion or contusion, but at times cases present themselves years after such an injury, or the latter has been so insignificant that no importance is ascribed to it. Such swellings may appear over any part of the vertex of the skull, and are due to the accumulation of cerebrospinal fluid between the scalp and the skull, which has escaped through an opening following a fracture. These swellings have, as a rule, a pulsation which is synchronous with that of the heart, but cases have been recorded where there is no pulsation. The swelling can be reduced, and when this is done, the edges of the skull opening can at times be felt. Often such a reduction causes compression symptoms.

FIG. 3.—MENINGOCELE SPURIA TRAUMATICA (Bayerthal).

These *spurious or false* meningoceles must be differentiated from the following conditions:

1. Deep cavernous angiomata. These may show distinct fluctuation and pulsation and can be decreased in size by compression, but firm pressure will cause all these signs to disappear. In addition there is no history of trauma, and no defect in the skull can be felt.

2. Blood-cysts beneath the pericranium, following fractures of the skull, which communicate with the longitudinal or lateral sinuses. They are called *sinus pericranii*, and are quite rare, only ten cases having been reported. They are more prominent when the patient bends forward, and are due to the rupture of an emissary vein which does not heal and which communicates with an endocranial sinus.

3. Congenital meningocele and encephalocele. These have a somewhat constant location in the frontal or the occipital region; there is an absence of a history of injury, and the defect in the skull is round and smaller than the tumor itself.

4. Soft sarcomata of the dura which form subcutaneous tumors after penetrating the skull. These may pulsate, and can be reduced by pressure, but do not fluctuate, and there is usually a history of gradual growth without preceding trauma.

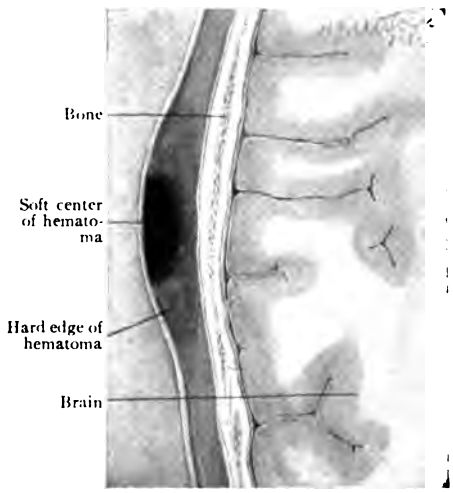

FIG. 4.—HEMATOMA OF SCALP, THE SOFT CENTER AND FIRM EDGE OF WHICH OFTEN SIMULATE FRACTURE (Scudder).

Subaponeurotic Hematoma vs. Depressed Fracture of Skull.—Extravasation of blood into the subaponeurotic layer of the scalp is one of the most frequent accompaniments of an injury of the head. When no scalp wound is present such an area of contusion may cause the question to arise as to the possible presence of a skull fracture. Its edges are frequently firm and elevated and its center soft and depressed, resembling under these conditions a depressed fracture of the skull. By passing the finger firmly from the surrounding uninjured scalp across the edge, one will find that the latter is above the level of the adjacent skull (Fig. 4) and can be pressed away. The edges of such a hematoma lack

the hardness of the skull bone and also the sharp outline of a fractured bone. In a simple, *i. e.*, closed depressed fracture of the skull, the finger passes directly from the level of the surrounding normal scalp into a depressions (compare Figs. 4 and 5).

In some cases, especially when there is an accompanying coma of uncertain origin and nonsurgical conditions have been excluded, the diagnosis of a simple contusion of the scalp is perplexing and justifies an exploratory incision carried out under proper precautions. The diagnosis becomes especially difficult when the patient is seen several days after the injury, and an infection of the hematoma has begun (see page 72).

The hematoma may be quite extensive and communicate with a ruptured artery of the scalp, causing distinct pulsations (pulsating hematoma).

At times after a fracture of the vertex, especially in children, a large hematoma will form without a scalp wound, but accompanied by symptoms of compression (see page 38). In one case observed by the author there was a direct communication between the scalp hematoma and a ruptured middle meningeal artery. The compression symptoms are the only means of diagnosing such an injury, and in their absence it would be impossible to trace any relation between a large hematoma of the scalp and intracranial hemorrhage.

FRACTURES OF THE SKULL.

The diagnosis of a fracture of the skull must be based upon a consideration of the following points:

I. The history of the mode of injury.

II. The direct examination of the vertex.

III. The interpretation of certain special signs indicating fracture of the base.

IV. Evidences of injury of the intracranial structures.

I. History of the Mode of Injury.

At the time of the accident this is of subordinate value, because a careful estimate of the evidence obtained from the other three factors will usually enable a diagnosis to be made. At a later period, however, the possibility of a fracture having been the result of a certain mode of injury may arise, and an exact history should be obtained.

In order to understand the mode of production of skull fractures, it is necessary to accept the theory of Aran that the skull is an elastic globe

which can change its shape up to a certain point, but beyond that its elasticity yields and a fracture results. When a force comes in contact with the skull, it may either (*a*) act upon some circumscribed small area or (*b*) over a larger surface, *i. e.*, in a more diffuse manner. Fractures which result from the first named or locally acting force are called bending or indentation fractures. Those which are the result of a force acting in a wider manner are called bursting fractures. The reason for applying the latter term will be understood if one thinks of the force acting upon a pole of the globe and then being in meridians. When the globe is compressed, the elasticity yields at one of these meridians and a

FIG. 5.—SIMPLE DEPRESSED FRACTURE OF THE SKULL IN AN INFANT, WITHOUT SYMPTOMS. NO TREATMENT. GRADUAL DISAPPEARANCE OF DEPRESSION (Elliot's Case).

bursting fracture results. A fall upon the vertex, feet, or buttocks is an example of such a diffuse force. A fracture following a blow with a hammer, a bayonet or sabre thrust, or a bullet or shell illustrates the variety due to the application of a localized force.

The history may be of some confirmatory value in the following instances: (*a*) Where a hematoma of the scalp (see page 21) resembles a simple depressed fracture. Here the history of some force applied in a concentrated manner should lead one to examine for other evidences of fracture, such as those of intracranial injuries. (*b*) Where bleeding from the nose, ears, and other signs of basal fracture exist without coma. A fall upon the vertex may by transmission of force produce

a fracture at the base by meridional distribution and such a history will be of aid in confirming the above evidences of a fracture of the base. (*c*) When Jacksonian epilepsy develops as a late sequel, the likelihood of a fracture having been sustained at the time of injury is greater, if there is a history of a blow having been struck by some instrument or missile (*e. g.*, mallet, iron bar, a rock, etc.) capable of producing a circumscribed injury.

II. Examination of the Vertex.

This must be made under one of *two* conditions: (*a*) Where no open wound exists as a result of the accident, as is the case in simple fractures; (*b*) where a wound of the scalp leads either directly or indirectly to the seat of the fracture, as in compound fractures.

(*a*) *Where no Scalp Wound is Present.*—Under these circumstances our only method of diagnosis from an examination of the skull lies in direct palpation of a fissure or of a depression. In the case of a fissure this is usually impossible unless the fissure is very wide, and in the absence of more direct evidence of intracranial injury, is absolutely unreliable as an aid to diagnosis. In the case of a depression apparently in the vertex, which can be felt by passing the finger over the intact scalp, the following conditions must be excluded before a diagnosis of depressed fracture should be made.

1. The possibility of a hematoma of the scalp resembling a depressed fracture (see page 21).

2. Normal depressions in the adult skull, especially in the aged. One should always compare the two sides of the skull a number of times when palpating it through the intact scalp.

3. Depressions due to congenital defects, *e. g.*, meningocele.

4. Depressions due to the presence of Wormian bones.

5. Depressions following the softening of syphilitic gummata with thickening of the periosteum at the edges of such a depression.

6. Depressions due to pressure on the head by the bony pelvis or by forceps during birth. Such depressions can occur in the infant's skull, owing to its great elasticity, and upon first examination feel like a depressed gutter fracture. They rarely persist, but correct themselves spontaneously within a few weeks (Fig. 5).

In a case of depressed fracture occurring without scalp injury the palpation of the irregular sharp edges of the bone will serve to distinguish it from the smooth edges of a congenital defect. The frequent location of the congenital defects in the parietal and occipital bones, will also be of aid.

In a case of depression following syphilis, the history and the presence of other evidences of the tertiary stage, will clear up the diagnosis.

At the present time the surgeon should never be content with making a diagnosis of depressed fracture of the vertex *without a visual inspection of the skull* through an exploratory incision made under proper precautions.

(*b*) *Examination of the Vertex where a Wound of the Scalp Exists* (*Compound or Open Fracture*).—Under these conditions the diagnosis is comparatively easy in the majority of cases by both inspection and palpa-

FIG. 6.—LOCATION OF MOST FREQUENT LINES OF FISSURED FRACTURE OF THE SKULL, EXTENDING INTO THE BASE.

Fissure extending through temporo-parietal bone into middle fossa; 2, fissure extending through occipital and temporal bones into base of skull, the petrous portion of the temporal bone.

tion at the seat of fracture if the patient is seen immediately after the injury.

A fissured fracture can be recognized as a fine, hair-like opening, from which blood escapes (Figs. 6, 7, and 8). At times the edges may gape. The fissure can be followed in many cases until it disappears at the base of the skull. One can differentiate it from a suture by the fact that it is impossible to rub the blood away in the case of a fracture. The diagnosis is confirmed in many cases by evidences of fracture of the base (see below), or by those of intracranial injury (see page 36).

A depressed fracture of the vertex can be readily diagnosed when

the edges of the scalp wound are retracted. The depression may be linear, *i. e.*, there may be one or more large fragments which have slipped under and are firmly fixed beneath the adjacent skull, or the depression may be gutter-like or it may be saucer-like, the center of the depression in the latter form resembling the center of a star, from which the lines of fracture radiate.

The diagnosis of a punctured fracture of the skull, such as follows a bayonet thrust, a bullet, or the use of some sharp object can be made—(*a*) from the history; (*b*) from the appearance of the wound, and (*c*) from the examination of the skull itself.

Punctured fractures of both vertex and base are comparatively infrequent. Those of the base are often overlooked because the external wound—*e. g.*, the thrust of a hat-pin, point of an umbrella, etc.—may be quite slight and far removed from the skull. There are often no suggestive symptoms until signs of intracranial mischief such as those of laceration or infection of the brain become manifest.

Gunshot Fractures of the Skull.

These form a separate class, both as regards the mode of production and the extent of the damage done. Those due to shells or slow-moving leaden missiles,[1] such as shrapnel bullets, may be (*a*) simple fissures; (*b*) depressed fractures without actual penetration of the skull by the missile, or extensive comminution of the bone. Fractures of the skull by rifle bullets are generally of three kinds: (1) Gutter fractures (Fig. 20), (2) penetrating fractures, and (3) complete perforations. In the fractures due to shell fragments the symptoms are usually those of concussion and compression, the injury to the brain being due only to the depressed bone fragments. In fractures of the skull by bullets there are, in addition to the injury and depressed bone fragments, the symptoms due to the penetration of the skull itself. The missile may lodge in the brain, in the entrance wound, or may glance off. In 133 fractures in the Boer war, over 45 per cent. were perforating. The injury to the brain or endocranial vessels will depend upon the velocity of the bullet, the extent of its penetration and the direction of the bullet. Next to the immediate effects of brain or vessel injury comes the later danger of infection. The diagnosis of the character of the fracture can be made from the history and inspection of the wound. The diagnosis of the presence or absence of intracranial complications, both immediately after the injury and later, can be made by an examination for the same evidences of intracranial

[1] The author is indebted to the article of Surg.-Gen. Robt. M. O'Reilly, in **Keen's** "System of Surgery," vol. iv, for much valuable information in relation to gunshot **wounds.**

injury as those occurring after ordinary fractures of the skull. The position of the bullet is best determined by taking antero-posterior and lateral skiagraphs of the skull.

The question may arise, How deep does the fracture extend? It may, in general, be said that:

1. Fractures of the external table alone can be diagnosed positively as involving this table alone, if the fragments are removed and the inner table found intact. Such a fracture may occur when the skull is struck obliquely by a sharp instrument, or in the mastoid or the frontal regions, where a considerable interval exists between the two tables of the skull.

2. Fractures of the internal table alone can be diagnosed only from the symptoms of the accompanying intracranial injury.

3. Fractures of both tables, of course, exist when there is a visible depression and after the majority of punctured or bullet wounds. In the latter two of these conditions the internal table is more extensively involved. In a fissured fracture one can diagnose a fracture of both tables if there is evidence of intracranial injury or if the fissure is enlarged by chiseling. This latter step is never justifiable for merely diagnostic reasons in the absence of serious symptoms.

FIG. 7.—FRACTURE OF FRONTAL AND NASAL BONES.

Diagnosis of Fracture of the Skull at a Later Period.—The question may arise months or perhaps years after an injury, when one of the late sequelæ, such as Jacksonian epilepsy, insanity, etc., has developed, as to whether a fracture had ever occurred. In the absence of a history from a reliable source, we must depend upon our objective examination, which may show one or all of the following:

1. Deformity in the shape of a depression of the vertex. All the conditions enumerated on page 24 must be excluded.

2. Hyperesthesia of the scalp, which can be determined by repeated tests.

3. A painful scar. At times pressure upon such a cicatrix may cause an aura.

4. Persisting evidences of intracranial injury or of fracture of the base, such as nerve paralysis, etc.

5. The development of a traumatic cephalhydrocele in children is positive proof of a fracture having occurred (see page 20).

FIG. 8.—FRACTURE OF OCCIPITAL BONE EXTENDING INTO THE POSTERIOR FOSSA.

The examination for evidences of a fracture of the base of the skull is made for one or more of the following signs:

1. Hemorrhages into or the presence of air in the subcutaneous tissues around the base.

2. Escape of blood, cerebrospinal fluid, or even brain substance externally from certain cavities, such as the ear, nose, and mouth, which communicate with the seat of fracture.

3. Evidence of injury of the cranial nerves or of the vessels at the base of the skull.

1. **Hemorrhages or the Presence of Air in the Tissues.**—Ecchymoses appearing in the eyelids, around the mastoid, or the nape of the

neck are of value in the diagnosis of basal fracture, if the blow has not been received over the region in which the subcutaneous hemorrhages have occurred, and especially if the latter begin to appear some hours after the injury, and increase in amount in the first few days. Orbital (subconjunctival) hemorrhages are quite frequently present, and, if excessive, an exophthalmos may be produced, which is almost positive evidence of a basal fracture. Escape of air into the subcutaneous tissues, producing emphysema or a crackling sensation of the skin upon palpation, occurs rarely after fractures communicating with the mastoid cells or frontal sinuses, and when found, is positive evidence of a fracture.

2. **Escape of Blood, etc., from the Ear, Nose, and Mouth.**—The escape of blood from the ear from other causes than a fracture of the base, is of short duration and small in amount. Bleeding may occur from one ear alone, or it may take place from both. If there is spurting of the blood, the internal carotid artery must have been torn. If it occurs in very large quantity without pulsation, a large sinus has been lacerated. Bleeding from the ear can be said to be due to a basal fracture, if after cleansing the ear and wiping out the blood, one excludes the following sources of hemorrhage: Tearing of the cartilaginous auditory canal in its anterior or posterior wall, simple rupture of the membrana tympani, and flow of blood from wounds of the scalp or external ear into the canal. The first and last of these can be eliminated by cleansing the ear and then observing the reaccumulation of blood. The rupture of the membrana tympani causes only a slight and transitory hemorrhage.

Blood escaping from the nose or mouth is only of diagnostic value if one can exclude local injury, and if it persists for a number of hours. Very rarely one can observe hemorrhage in the retropharygneal structures or the escape of blood from the Eustachian tube, when the membrana tympani is not torn.

In an article[1] upon 530 cases of fracture of the base of the skull observed in the Boston City Hospital, Crandon and Wilson state that 74 per cent. had bleeding from the ears, nose or mouth, usually from one ear only. The ear drum was always broken. Pharyngeal bleeding was to be interpreted as a sign of severe injury. The escape of cerebrospinal fluid from the ear or nose was only noted in 27 cases—less than 5 per cent.

The flow of cerebrospinal fluid most often occurs from the ear, and can be distinguished from blood-serum by the large quantity of watery fluid, the high percentage of sodium chlorid and the small percentage of albumin which it contains.

[1] "Annals of Surgery," December,

Less frequently cerebrospinal fluid may escape from the mouth or nose. Several cases have been reported where a diagnosis of basal fracture has been confirmed by the flow of cerebrospinal fluid persisting lor years after the injury (rhinorrhea). The flow, whether from the nose, mouth, or ear, is increased by coughing or any form of exertion.

FIG. 9.—METHOD OF MAKING PRESSURE UPON THE SUPRAORBITAL NERVES.
To be employed in the diagnosis of certain intracranial affections (see text). The examiner should stand behind the patient's head, and make pressure with the index-finger of each hand over the supraorbital notches.

The escape of brain tissue is rare, except in fractures involving the orbit or the temporal bone, and, when present, is absolute evidence of a fracture. One can then find ganglion-cells microscopically.

3. **Injuries of the Nerves and Vessels at the Base.**—(*A*) *Injuries of Nerves in Basal Fractures.*—In fractures of the base, certain cranial nerves are more frequently injured than others, owing to the fact that the majority of the fractures pass through the petrous portion of the

temporal bone (Fig. 6), and from here forward. One should always examine a patient for evidences of paralysis of the seventh, sixth, third, and fourth nerves in the order named, and then the remaining nerves. At the same time one must not forget that injuries of all of these nerves can occur *without fracture of the base*, so that a diagnosis of fracture should not be made from nerve paralysis alone, but by careful consideration of the other signs, as subcutaneous hemorrhages, flow of blood or cerebrospinal fluid from ears, nose, and mouth taken in conjunction with the evidences of nerve or vessel injury at the base. In addition to these three factors, in making a diagnosis, a fourth is to be added, and that is whether the accompanying signs of injury to the brain (to be considered later) confirm the diagnosis already rendered probable by the other three.

Injury of the Facial Nerve.—This shows itself as a peripheral paralysis affecting the ocular, labial and nasal groups of muscles. When the case is first examined, this paralysis may often be demonstrated by pressure upon the supraorbital nerves, as shown in Fig. 9. This manipulation, unless the coma is extremely deep, causes such pain that the patient will contract the facial muscles of the non-paralyzed side. It is also of aid in distinguishing genuine from feigned unconsciousness or from an alcoholic stupor.

FIG. 10.—FACIAL PARALYSIS OF PERIPHERAL ORIGIN FOLLOWING GUNSHOT WOUND OF RIGHT FACIAL NERVE.

Note the inability to contract the muscles of the eyelids and the muscles of expression of the face proper, resulting in obliteration of the nasolabial fold and drooping of the angle of the mouth.

The paralysis of the facial nerve is usually unilateral and may involve other branches of the nerve beside those supplying the muscles of expression. The paralysis is rarely permanent. It, like evidences of injury to all the nerves at the base, may not appear at the time of the accident, but several days later, owing to a secondary periostitis.

Injuries of the Third, Fourth, and Sixth Nerves.—Injury of the

third cranial or motor oculi nerve causes external strabismus and ptosis. The pupil is widely dilated and does not react to either light or accommodation. There is also double vision. Injury of the *fourth* nerve causes diplopia. In attempts at downward convergent vision the internal rotation of the eyeball fails to take place.

Paralysis of the *sixth* nerve results in internal strabismus and marked diplopia. The injuries of all these nerves are usually unilateral, owing to their involvement in fractures involving the base close to the apex of the orbit, and the paralyses often occur together.

Injury of the Auditory Nerve.—According to some authors (Rawling), the seventh and eighth nerves are more frequently injured than any others, but others (Graf and Brun), from the analysis of a large number of cases, state that the order given above, viz., seventh, third, fourth, and sixth, represents the greater frequency of involvement. Crandon and Wilson found that paralysis of the seventh and eighth usually occurred together.

The eighth nerve is most frequently involved in fracture of the base with the seventh, and upon this association rests much of the question as to whether the deafness resulted from the injury. If the auditory nerve is injured there is loss of hearing by bone conduction and loss of hearing of the higher tones. The deafness usually disappears unless the ossicles are broken.

Injuries of the Olfactory Nerve.—The effect of injury to this nerve is anosmia, or a loss of sense of smell on the side of injury. The presence of anosmia aids in localizing the fracture in the anterior fossa (cribriform plate of ethmoid). One must rule out hysteria, catarrhal nasal conditions, and fifth-nerve disturbances, since true anosmia as a result of basal fracture is quite rare.

Injury of the Optic Nerve.—A fracture of the base may be followed by choked disc, because the dural covering of the nerve is injured; this quickly subsides, but an optic atrophy may remain.

Injury of the Trigeminal Nerve.—This nerve is seldom involved in fractures of the base, and if so injured, it only involves the ophthalmic branch, as a rule. There may be both sensory and motor disturbances. The motor are loss of function of the masseter and pterygoid muscles on the side of the injury, so that the patient is unable to keep the jaws tightly together. The loss of sensation involves almost the entire lateral half of the face, the conjunctiva, nasal and buccal mucous membranes, including the tongue, often causing a trophic ulcer of the cornea.

Injury of the Ninth, Tenth, and Eleventh Nerves.—Comparatively

few cases of injuries to these nerves have been reported following fracture of the base. The paralyses of all three of these nerves are often associated, on account of their close relation at the base. In four of the cases reported there was dysphagia from paralysis of the palatal muscles. There were also disturbances of speech and of voice, due to paralysis of the recurrent laryngeal. In three of five cases there was unilateral anesthesia of the pharynx and larynx, and in two, disturbances of taste.

In several cases in which there has been predominant involvement of the eleventh or spinal accessory, it causes slight difficulty in raising of the arm, due to paralysis of the trapezius (Fig. 11) muscle.

FIG. 11.—PARALYSIS OF THE RIGHT TRAPEZIUS MUSCLE, AS A RESULT OF CUTTING THE SPINAL ACCESSORY NERVE DURING AN OPERATION FOR TUBERCULAR GLANDS OF THE NECK.

P. Points to the paralyzed muscle. Observe the depression on the right side of the neck (paralyzed side).

Injuries of the Twelfth or Hypoglossal Nerve.—This nerve is also rarely involved, very few cases having been reported. Its paralysis causes difficult deglutition, atrophy of the tongue, and speech is affected. Its injury is almost always in association with that of the ninth, tenth, and eleventh nerves.

(*B*) *Injuries of the Vessels at the Base of the Skull in Fractures of the Same.*—The diagnosis of these has been briefly referred to on page 29. Special interest, however, is attached to cases of fractures of the base accompanied by simultaneous injury of the internal carotid artery and cavernous sinus, resulting in the formation of an arteriovenous aneurysm. This result of a fracture of the base can be diagnosed by the presence of a pulsating exophthalmos. There is marked protrusion of the eyeball; the upper eyelid is swollen and tense, and there is a dis-

tinct pulsation and bruit—the latter two, in cases where the common carotid is compressed. Pulsating exophthalmos may, however, follow a fracture (gunshot wound of petrous portion of temporal) at another part of the skull, as reported by Barnard,[1] and then be due to as acculated aneurysm of the internal carotid, without venous communication. In 313 cases of pulsating exophthalmos collected up to the middle of 1907 by G. E. de Schweinitz,[2] over two-thirds were the result of trauma. The symptoms may appear immediately after the injury or

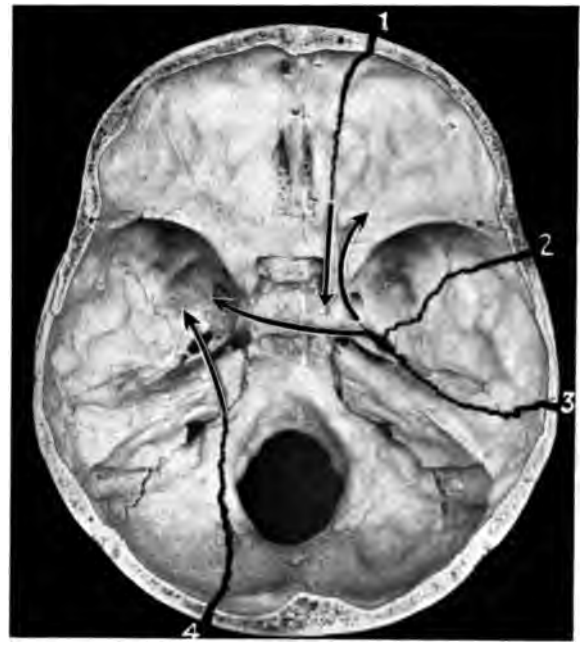

FIG. 12.—MOST FREQUENT LINES OF FRACTURE OF BASE OF SKULL.
The black arrows indicate their direction if they traverse further than indicated in the illustration: 1, Fracture of anterior fossa; 2, 3, fractures of middle fossa; 4, fracture of posterior fossa.

some days to even years later. The reader is referred to the excellent article of de Schweinitz for a more detailed account of this condition.

Diagnosis of Fracture of Individual Fossæ of the Base.—In addition to being able to make a diagnosis of fracture of the base *per se*, it may also become necessary to ascertain through which fossæ the fracture has occurred. The majority of fractures of the vertex

[1] "Annals of Surgery," May, 1904.
[2] Keen's "System of Surgery," vol. iv.

due to a fall from a height or a blow upon the skull by some blunt instrument are followed by a fracture of the corresponding fossa of the base. The statistics of Brun show that 75 per cent. of fractures of the vertex are accompanied by a fracture of the base, and that the middle fossa is

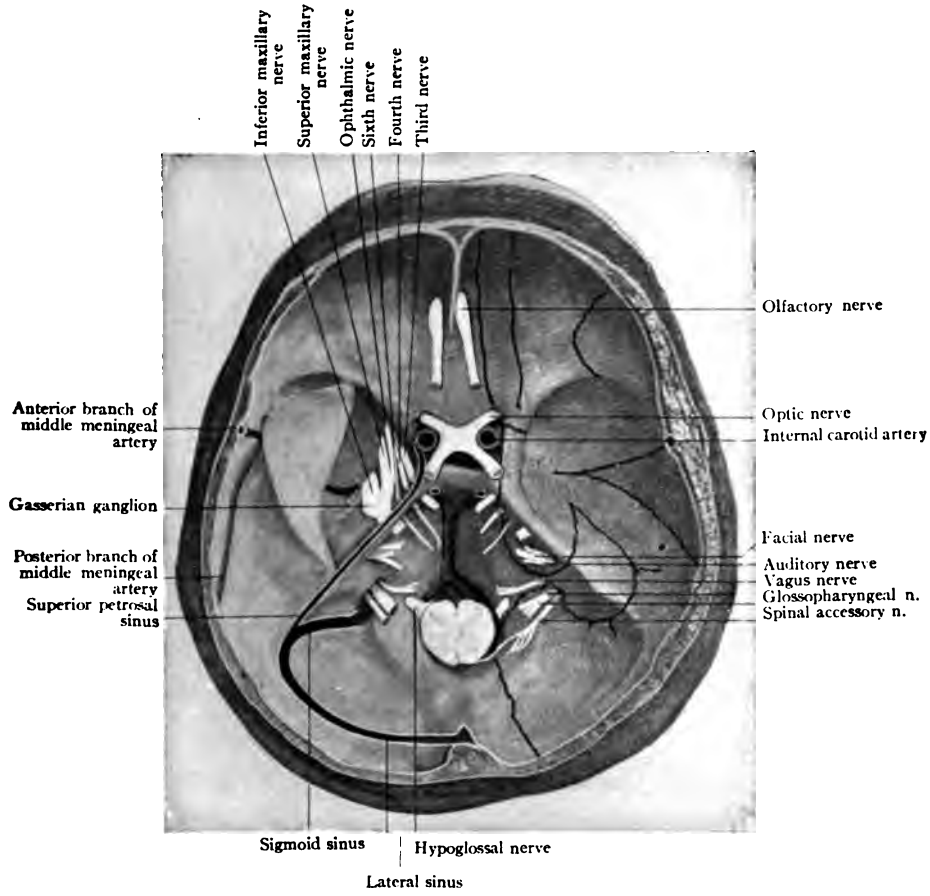

FIG. 13.—VIEW OF BASE OF SKULL, SHOWING RELATION OF CRANIAL NERVES, CAROTID AND MIDDLE MENINGEAL ARTERIES, AND SINUSES TO THE FOSSÆ.

This illustration shows on the right side of the skull the most frequent lines of fracture at the base of the skull

the one most often involved. In many cases of fracture of the base following a punctured or gunshot wound, the location of the wound of entrance is of assistance.

The greater number of basal fracture lines pass through the petrous portion of one or both temporal bones, either as extensions or isolated fractures.[1] Many fractures involve two or more fossæ (Fig. 12).

[1] Patel: "Revue de Chirurgie," April, 1903.

Aside from these facts, the following table may be of aid (Fig. 13):

Fractures of anterior fossæ	1. Subconjunctival and subcutaneous (eyelids) hemorrhages. 2. Exophthalmos (due to retrobulbar hemorrhage). 3. Bleeding or escape of cerebrospinal fluid or brain substance from the nose or mouth. 4. Pulsating exophthalmos. 5. Anosmia (due to olfactory nerve injury).
Fractures of middle fossæ	1. Subcutaneous hemorrhages around the mastoid. 2. Bleeding and escape of cerebrospinal fluid or brain substance from the ear and mouth (per Eustachian tube). 3. Signs of injury of second, third, fourth, fifth, sixth, and at times of seventh cranial nerves (see pages 30, 31).
Fractures of posterior fossæ....	1. Subcutaneous hemorrhages at upper part of back of neck. 2. Evidence of injury of seventh, eighth, ninth, tenth, eleventh, and twelfth nerves. 3. Bleeding from the ear.

Albuminuria and glycosuria have been reported after basal fracture, but are of no diagnostic value.

IV. Evidences of Intracranial Injury.

In by far the greater number of cases a fracture of either the vertex or of the base is accompanied by unconsciousness and other symptoms of intracranial injury. This is especially true of depressed fractures of the vertex, fissured fractures of the temporal region (middle meningeal hemorrhage), and the majority of fractures of the base.

The diagnosis of which particular form of injury to the intracranial structures has occurred depends, first, upon the length of time which has elapsed since the accident; and, second, upon a careful analysis of the symptoms.

The length of time since the accident is of value because there is a certain sequence in which symptoms of the various conditions show themselves.

1. In the first forty-eight hours concussion, compression, and contusion symptoms appear.

2. After the first forty-eight hours symptoms of spreading edema, meningitis, cerebral abscess, hernia cerebri, and pyemia from sinus thrombosis may begin to appear. Quite rarely compression symptoms may show themselves for the first time some days after an injury, a condition known as late traumatic apoplexy (page 95).

3. After the immediate effects of injury have either disappeared or improved, the so-called late sequela, such as traumatic neuroses, epilepsy, and chronic traumatic abscess, may appear.

In the majority of cases it is of the utmost importance, both as regards prognosis and treatment, to make a diagnosis as soon as possible after the accident. This can be done at times after the first examination of the injured person. In other cases a second or third analysis of the symptoms at intervals of a few hours will usually enable a diagnosis to be made, even where two or more of these intracranial conditions are present together.

Concussion, compression, and contusion of the brain usually occur as complications of fractures either of the vertex or base, so that the presence of such a fracture must be taken into consideration in the diagnosis of intracranial injuries. It must, however, not be forgotten that serious damage to the brain, intracranial blood-vessels, and nerves may also occur after mere contusions of the skull (see page 46), after falls upon the feet or buttocks, or after blows or falls upon the chin or head *without a fracture of the skull.*

CONCUSSION OF THE BRAIN.

Concussion symptoms always appear immediately after the injury, but vary somewhat in their severity. They occur with especial frequency after fractures of the base. Graf found concussion symptoms in 76 of 90 cases of fracture of the base. There are three classes of cases: (*a*) mild; (*b*) moderately severe, and (*c*) severe. There is usually an initial stage of depression, and a second stage of irritation or reaction.

FIRST OR STAGE OF DEPRESSION.

Mild Cases.	Moderately Severe.	Severe.
1. Unconscious for a few seconds to minutes, rarely half an hour.	1. Unconscious for a number of hours.	1. Unconscious for a short period, followed by death.
2. Pulse but little affected.	2. Pulse rapid and small.	2. Pulse rapid and weak.
3. Respirations a little slower than normal.	3. Respirations slow and shallow.	3. Respirations shallow and rapid.
4. Skin pale and cold.	4. Skin pale, cold, and clammy.	4. Skin pale, cold, and clammy.
5. Vertigo, tinnitus, or flashes of light.	5. Pupils contracted or dilated, equal, and respond to light.	5. Pupils same as in moderately severe.
6. No memory of events just before accident.	6. No memory of events before accident, when reaction sets in.	
7. No rise in blood-pressure.	7. Involuntary micturition and defecation.	7. Same as in moderately severe.
	8. Vomiting—either during period of unconsciousness or upon recovery from same.	8. Subnormal temperature.

STAGE OF DEPRESSION.—(*Continued.*)

MILD CASES.	MODERATELY SEVERE.	SEVERE.
	9. Traces of sugar or albumin or both in urine.	9. Rise in blood-pressure in early portion, but rapid fall as vasomotor and other centers in the medulla become paralyzed.
	10. Rise in blood-pressure immediately after trauma.	

SECOND, OR STAGE OF IRRITATION OR REACTION.

1. Pulse becomes stronger and more rapid, until normal.
2. Respirations deeper and more rapid, until normal.
3. Surface of skin becomes warmer and redder.
4. Temperature normal or slightly above.
5. Great mental irritability and apathy.
6. Some vomiting.

The symptoms of concussion in the average case will be considered below in differentiating it from compression and contusion (see page 95). In the average case of concussion there is always more or less accompanying contusion of the brain or hemorrhages into the piaarachnoid (see Fig. 17). If the contusion has occurred in a portion of the brain whose function is not known, the concussion symptoms predominate. If, however, the contusion affects the motor cortex on both sides of the cerebrum, bilateral twitchings are often an accompaniment of the concussion. In general, it may be said that if the concussion symptoms are of long duration, more or less contusion should be suspected unless the clinical signs of a concussion show a distinct change to those of compression.

COMPRESSION OF THE BRAIN.

The symptoms of cerebral compression of traumatic and non-traumatic origin vary both in their intensity and in the time of onset, according to the cause, as follows:

I. Compression from splinters of depressed fracture (Fig. 14). The symptoms appear almost immediately after the injury and are associated with those of concussion and contusion (see table on page 95).

II. Compression from intracranial hemorrhage.

This may arise—(*a*) from the middle meningeal artery (extradural hematoma or in pachymeningitis hemorrhagica.

(*b*) From the piaarachnoid (subdural hematoma or intermeningeal hemorrhage).

(*c*) From the vertebral arteries and intracranial portions of the internal carotids.

(*d*) From the venous sinuses.

Compression from any of these causes appears in one of four ways:

1. First, the patient shows symptoms of concussion, then a free interval occurs which is followed by compression symptoms.

2. There is a distinct interval after the accident without any symptoms of intracranial injury, then signs of compression begin to appear.

3. No perceptible interval between the symptoms of concussion and of compression, the symptoms of the concussion at first obscuring those of the compression.

4. Compression symptoms may rarely appear a number of days after the accident (late traumatic apoplexy).

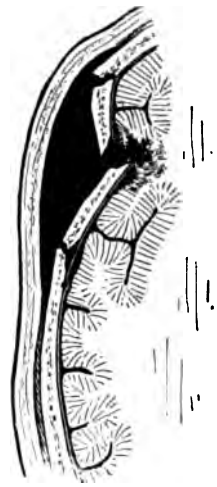

FIG. 14.—FRACTURE OF SKULL WITH DEPRESSED FRAGMENTS (Scudder).

Compression of brain by bone.

III. Compression symptoms from infection of the meninges or the brain, or from tumors of the brain.

Signs of cerebral compression due to infection appear after the first forty-eight hours (page 61).

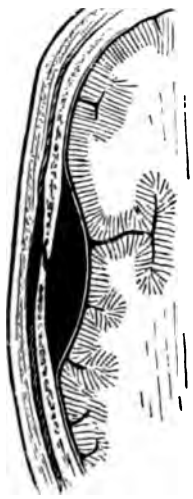

FIG. 15.—FRACTURE OF SKULL WITH MIDDLE MENINGEAL HEMORRHAGE (Scudder).

Compression of brain by blood.

Compression symptoms due to extradural hematoma from a laceration of the middle meningeal artery appear early, and are quite marked within a few hours after their onset. In elderly persons there is usually no interval at all, or a very short one, between the time of onset of the symptoms of concussion and those of compression. Hemorrhage from injury of the vessels of the pia arachnoid or the sinuses cannot be distinguished from middle meningeal hemorrhage in the majority of cases, but it frequently appears later, is less rapid, and the symptoms are not so marked (see page 54).

The experimental work of Kocher[1] and of Cushing[2] on the subject of cerebral compression is being so rapidly confirmed by clinical obser-

[1] Nothnagel's "Specielle Pathologie," Bd. ix, 3.

[2] "American Journal Medical Sciences," June, 1903.

vations, that the classification given by them will be followed here. According to these writers, there are four stages of compression of the brain.

First, or State of Compensation.—There are practically no symptoms with the exception of severe headache, which may be due to irritation of the dura.

Second, or Early Stage of Manifest Pressure.—The symptoms of this stage are due to an obstruction to the outflow of venous blood (dysdiæmyrrhosis). They are:

(*a*) Headache—location varies according to seat of lesion.

(*b*) Delirium, great irritability, and restlessness.

(*c*) Dullness of perception.

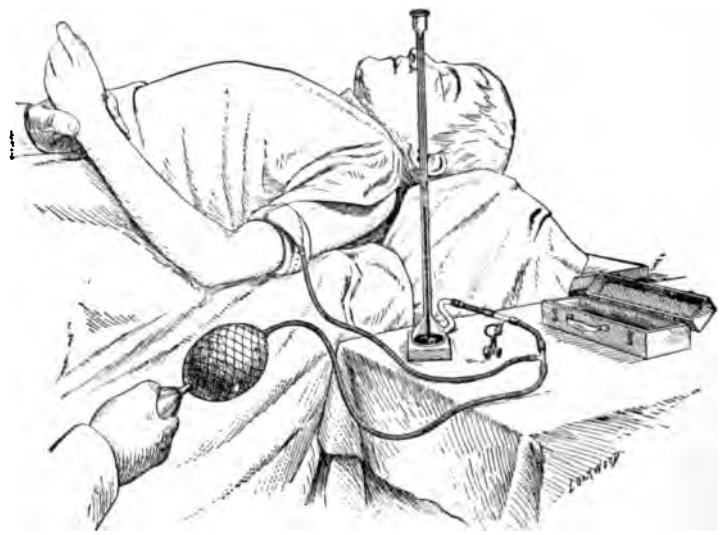

FIG. 16.—RIVA-ROCCI SPHYGMOMANOMETER AS MODIFIED BY COOK.

(*d*) Pupils contracted or unequal. May have conjugate deviation of eyeball.

(*e*) Choked disc.

(*f*) Pulse slower than normal (50 to 70) unless there is much fever. Tension moderately increased.

(*g*) Respiration slower than normal, but regular.

(*h*) Temperature higher than normal (101° to 103°). The greater the degreee of compression, the higher the temperature. On page 47 reference is made to the fact that one of the most characteristic evidences of the presence of cerebral contusion is fever. If there is moderate elevation and the temperature remains stationary, the essential or para-

mount lesion is compression from hemorrhage, whereas if the temperature is quite high, cerebral contusion predominates.

(*j*) Rise of blood-pressure. This can be determined by the use of the modified Riva-Rocci apparatus (Fig. 16).

In cases of compression in the second stage (incipient or mild compression), there will be moderate increase of blood-pressure to 180 to 190 mm. of Hg. If this does not rise, it indicates that the intracerebral tension has not increased. Concussion will cause a rise in blood-pressure immediately after the accident, but it decreases as the symptoms subside. In cases where moderate compression exists, in addition to the concussion, the blood-pressure either remains stationary or there is a light rise, due to a posttraumatic cerebral edema (Cannon-Bullard[1]).

Third, or Stage of Manifest Pressure.—In this stage the compression is so great as to cause an anemia of both the cortex and the medulla (adiæmyrrhosis). The vasomotor center is stimulated and causes such a rise in blood-pressure that it compensates for the increased intracranial tension. The diagnosis of this stage of compression may be made from the following (see footnote[2]) symptoms:

(*a*) The patient is deeply stuporous and gradually becomes comatose.

(*b*) The pupil is dilated and not responsive on the side of the lesion. There may be conjugate deviation of the eyeballs toward the side of the lesion.

(*c*) Marked choked disc.

(*d*) Pulse very slow unless there is fever. May drop to 40 or 50 and is of high tension.

(*e*) Respirations much slower than normal and stertorous. They may be Cheyne-Stokes in character.

(*f*) Temperature higher than normal. It rises as the compression increases.

(*g*) Blood-pressure greatly increased. In case the hemorrhage (if this be the cause of the compression) is subdural (intermeningeal), the increase is slow and only moderate; if, however, there is a large extradural clot or a large fragment of depressed bone, the rise will be rapid and quite marked, falling soon after the pressure is relieved, or if this does not occur, the fourth or stage of paralysis sets in, with

[1] "Boston Medical and Surgical Journal," August, 1901.

[2] The symptoms of this stage should be compared with those of the early stage of manifest pressure.

its marked fall of blood-pressure. Following the primary fall after the operation there may be a second rise, due to a variable degree of cerebral edema.

(*h*) Focal symptoms. These may or may not be present, according to whether or not the pressure is exerted over a localized area. If present, there may be hemiplegia on the opposite side, or a monoplegia, sometimes preceded by twitchings or convulsions of the affected muscles. There is also increase of the deep or tendon reflexes, with loss of control of the bladder and rectum.

Fourth, or Stage of Paralysis.—In this stage the intracranial tension can no longer be compensated for by increased blood-pressure, and there is inhibition of the functions of the medulla through extreme anemia. The symptoms are usually preceded by those of the third, or stage of manifest pressure. In this terminal or paralytic stage the diagnosis may be made from the following symptoms:

(*a*) Deep coma. The patient cannot be aroused.

(*b*) The pupils are dilated and not responsive.

(*c*) The pulse is rapid and weak, corresponding to the fall in blood-pressure.

(*d*) The respirations are shallow and irregular. Frequently they are of the Cheyne-Stokes' type.

(*e*) Rapid fall in blood-pressure.

Differentiation of Compression Coma from other Forms of Coma.

Many patients are seen under one of the following conditions, when the differential diagnosis must be made between coma due to cerebral compression and that due to other causes:

1. A comatose middle-aged man or woman is brought to the hospital with the history of having fallen on the street and received a scalp wound, an hour or less before admission.

2. Same condition and history as above, but smell of alcohol in breath very marked.

3. Man apparently deeply unconscious, with no external wound or signs of injury, but with a history of having fallen, six or eight hours before examination.

One must distinguish the symptoms of traumatic cerebral compression under any or all of the above conditions from the following forms of feigned or genuine coma:

(*a*) Coma due to ordinary cerebral apoplexy or to pachymeningitis hemorrhagica.

(*b*) Uremic coma.
(*c*) Diabetic coma.
(*d*) Alcoholism.
(*e*) Opium poisoning.
(*f*) Hysterical coma (or often malingering).

The diagnosis which is the most difficult, is in the class of cases mentioned under 3, where the patient has, for example, been placed in the cell of a police station over night, with a diagnosis of alcoholism made by the officers. Here the fall was originally due to the alcohol, but resulted in a skull fracture with hemorrhage, and the free interval between concussion and compression either did not exist, or was overlooked. This instance is especially referred to on account of the fallacious teaching *that symptoms of compression are always preceded by a free interval*, which latter is diagnostic of this condition. Every case of coma must be systematically examined before a diagnosis is made. The average duration of life in non-operated cases of middle meningeal hemorrhage is 25 hours (Brun), and this fact emphasizes the importance of an early diagnosis of cerebral compression of traumatic origin.

The differential diagnosis of the various forms of intracranial injury will be taken up at the end of this section. As can be seen from the accompanying table, it will not be difficult to make a diagnosis of the nature of the coma, if the patient is systematically examined, as to—(*a*) the history preceding the onset, if obtainable, (*b*) the condition of the pupils, (*c*) examination of the skull, (*d*) examination of the extremities as to paralysis, (*e*) observation of the pulse, (*f*) respiration, (*g*) temperature, (*h*) urine, and finally if an (*i*) ophthalmoscopic examination is made.

CEREBRAL CONTUSION OR LACERATION.

The symptoms of injury of the brain are due either (*a*) to punctate or somewhat larger foci of contusion, which may involve various area of the cortex, the conducting tracts, the cerebellum, the pons, and the medulla or (*b*) it may be the result of a mechanical destruction of the nervous elements, which it is impossible to demonstrate (Fig. 17).

Contusion may be either direct, *i. e.*, in close relation to the seat of injury, or it may be indirect, at the end of the poles of force which start at the point of impact.

Evidences of contusion are usually most marked at the base of the brain, especially in the cerebellum, pons, and medulla. Next in order

Coma from Intracranial Injury.	Apoplectic Coma.	Uremic Coma.	Alcoholic Coma.	Opium Poisoning.	Hysterical or Malingering.	Diabetic.	Hemorrhagic Pachymeningitis.
Deep coma, may have history of onset after fall or injury. Evidence of fracture of vertex or base.	Deep coma; sudden onset. If any injury, only a scalp wound.	Deep coma. Slow onset unless convulsions have preceded the coma.	Can be aroused by supraorbital pressure unless very profound.	Can be aroused unless very deep.	Can be aroused by supraorbital pressure (Fig. 9).	Deep coma. Sweetish odor to breath.	History of previous attacks of coma or coma occurs after slight injury.
Pupil often dilated on side of lesion. Choked disc.	Pupils unequal or dilated. Contracted in hemorrhage into the pons.	Albuminuric retinitis.	Pupils normal or somewhat dilated.	Pupils contracted to pinpoint size.	..	..	Occurs in chronic alcoholism.
Pulse very slow.	Pulse full and slow, often arteriosclerotic, high-tension pulse.	Pulse rapid.	Pulse more rapid than normal and full.	Pulse rapid, may be irregular.	..	..	Attack preceded by severe headache.
Respiration slow and stertorous.	Respiration slow and irregular.	Respiration frequent and irregular.	Regular respiration.	Respiration very slow—may be 6 to 8 per minute.	..	..	..
Temperature higher—101°.	Temperature higher on paralyzed side, but lower in rectum.	..	May be low or normal.	..	..	..	..
Urine normal or contains trace of albumin.	Urine contains trace of albumin, but may be same as in uremia.	Urine shows albumin, casts, and low urea percentage.	Normal.	Normal.	..	The urine contains variable amount of sugar and diacetic acid.	..
Hemiplegia on opposite side to that of injury. If contusion of brain is also present, may have generalized convulsions.	Hemiplegia with convulsions on one side.	..	..	..	..	..	..

of frequency are the frontal and temporo-sphenoidal lobes (Fig. 17). Sixty per cent. of the deaths in the first twelve hours in 470 cases of skull fractures, observed at the Heidelberg clinic (Brun), were found to be due to contusion of the brain and this was most marked in the cerebellum.

Bullets, blunt instruments thrust into the skull, or the splinters of a depressed fracture cause localized foci of contusion, also called laceration of brain substance, *whose symptoms depend primarily upon the area involved, i. e.*, upon their degree of penetration. The symptoms

FIG. 17.—SAGITTAL SECTION OF BRAIN IN A CASE OF EXTENSIVE TRAUMATIC HEMORRHAGE INTO THE FRONTAL LOBES

B, Large clot occupying a cavity in the frontal lobe. Note the hemorrhages into the piaarachnoid as seen in the sulci along the upper surface.

produced immediately after the injury do not differ from those resulting from a non-penetrating force.

Contusion or laceration of the brain may be present under one of several different clinical pictures, as follows:

(*a*) As generalized or localized convulsions, obscured from further recognition by the symptoms of concussion or compression, or the occurrence of convulsions during the first forty-eight hours, accompanied by a marked rise in temperature and delirium. After this period, such symptoms are due to infective conditions, such as meningoencephalitis (see page 64). In general, it may be said that persistent high temperature during the first days after a head injury signifies cerebral contusion, especially if it is accompanied by convulsions, unilateral or bilateral.

(*b*) As early focal symptoms (aphasia, etc.) in cases where the signs of concussion or compression are either absent or present only for a short interval.

(*c*) As late focal symptoms which show themselves (in the form of pareses or paralyses, etc.) during convalescence from the immediate effects of an injury such as concussion or compression.

FIG. 18.—VIEW OF BASE OF BRAIN IN A CASE OF EXTENSIVE TRAUMATIC HEMORRHAGE INTO THE FRONTAL LOBES.

Same case as shown in Fig. 17. B, B, Blood-clots occupying a large cavity in the right frontal lobe.

(*d*) In some cases of cerebral contusion, even without demonstrable fracture of the skull, a cerebral abscess may develop during the first two to three weeks after the injury. The onset of symptoms does not differ from that seen in the acute traumatic variety of cerebral abscesses described on page 64.

The diagnosis of the first of these three groups (*a*) is a very difficult one. This is due to the fact that the symptoms of concussion (loss of consciousness, slow pulse and respiration, etc.), or again those of

compression (very slow pulse and respiration, deep coma, etc.), may in some cases obscure the clinical picture to such an extent that it is impossible to make an absolute diagnosis of a contusion. One can surmise its presence when twitchings or convulsions accompanied by high temperature appear immediately after the injury. These convulsions are at times present only on the side of the injury; at others on the opposite side of the body, or again are quite generalized. All of these symptoms show an irritation of the cortical centers.

The second class of cases (*b*) is much easier to diagnose, for the reason that the loss of consciousness was very slight or transitory, or not even present. The signs of brain contusion most frequently found in these cases are pareses or paralyses of the face, arm, or leg of the side of the body opposite to that of the injury, with or without aphasia. The aphasia may appear as an isolated paralysis, and by some writers (Koenig) is considered as one of the most characteristic signs of contusion of the brain. The correct interpretation of the early signs of focal brain injury, as well as of those occurring in the manner described in class *c* (*i. e.*, after the symptoms of concussion or compression have begun to disappear) can be made only if we recall the more important facts in our present knowledge of cerebral localization. In other words, *we can diagnose contusion only from certain symptoms indicating focal lesions plus temperature.* According to Phelps,[1] the temperature is the most important indication of the nature of the essential lesion. Its degree of elevation measures the extent of the injury to the cerebral tissue. If moderately elevated and nearly stationary it means superficial (piaarachnoid) hemorrhages (Fig. 17) with slight cerebral implication. If high, the cerebral contusion and progressive it indicates serious cerebral changes. Remissions and exacerbations signify (aside from septic complications) fluctuations in hyperemia and edema.

CEREBRAL LOCALIZATION (Figs. 19-23). (See foot-note.)

I. **Ascending Frontal Convolution (Precentral Gyrus):**

(*a*) Motor centers for leg in upper third.

(*b*) Motor centers for arm in middle third.

(*c*) Motor centers for face and tongue in lower third.

[1] "Annals of Surgery," December, 1906.

[2] The best-known cortical areas are the motor, speech, visual, auditory, smell and psychical. Grunbaum and Sherrington (in 1902) have demonstrated in the cortex of the higher apes, that the motor area was found the whole length of the precentral convolution and the entire length of the central fissure of Rolando. These observations have been

The total destruction of the entire precentral gyrus would result in complete and permanent hemiplegia of the opposite side of the body.

Most frequently the cortical centers are not completely destroyed, so that the paralysis involves only one or more of the centers, and is accompanied by evidences of cerebral irritation from contusion or com-

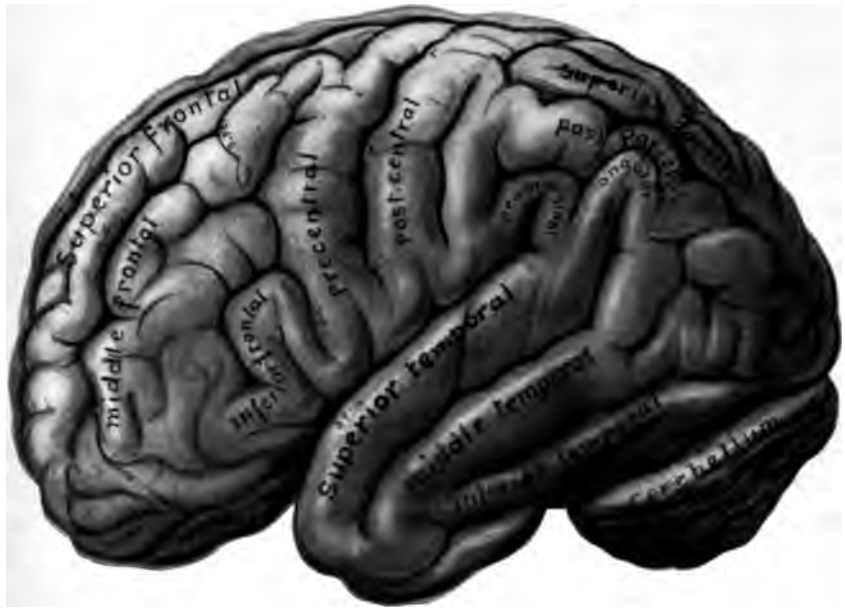

FIG. 19.—LATERAL ASPECT OF LEFT SIDE OF BRAIN.

L. f. Longitudinal fissure; *r.*, *r.*, *r.*, Rolandic fissure; *i. pc.*, *s. pc.*, inferior and superior precentral; *sf.*, *if.*, superior and inferior frontal; *sp. s. asc.*, posterior and ascending limbs of Sylvian fissure; p^1, p^2, p^3, p^4, inferior, superior, horizontal, and occipital limbs of interparietal; *p-o*, parieto-occipital; *t. o.*, *l. o.*, transverse and lateral occipital; t^1, t^2 *asc.*, superior temporal and its upturned limb; t^2, t^2 *asc.*, middle temporal and its upturned limb.

pression, in the form of twitchings or convulsions. The combination of these latter irritating symptoms with paresis or paralysis of the extremities or facial muscles is diagnostic of cerebral contusion or compression. Some partial destruction of the motor cortical centers is often

confirmed by Krause, Mills, Spiller and others on man. Before the publication of the works of Sherrington and Krause, the motor zone was regarded as extending over both central convolutions. It is now generally accepted that the motor region is entirely or almost entirely in front of the fissure of Rolando (Fig. 23). Each movement, of the face, tongue, arm, trunk and leg, is represented by a definite area of the cortex (Fig. 23). It is now considered probable that the cutaneous sensory centers are posterior to and in close contact with the motor centers, in the postcentral convolution, while other centers for stereognostic perception and the muscular sense are located in the superior and inferior parietal convolutions.

associated with aphasia and sensory disturbances (muscle sense), owing to the proximity of these centers. One of the following combinations may occur:

1. Paralysis or clonic convulsions, or both, of the arm (monoplegia and monospasm). This is often accompanied by a loss of muscle and stereocognostic senses.

2. Same condition of leg alone. Less often than in the arm there is a loss of muscle and stereocognostic senses. Monoplegia, etc., of the leg alone is not as frequent as in the arm. Lesions are much more likely to involve two adjacent areas, as of the face and arm, or of the arm and leg.

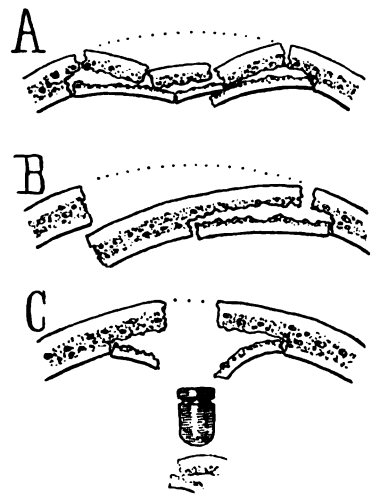

FIG. 20.—DIAGRAM OF (A) COMMINUTED FRACTURE WITH CENTRAL DEPRESSION; (B) ONE WITH PERIPHERAL DEPRESSION; (C) ONE WITH LOSS OF SUBSTANCE. (Cushing.)

3. Isolated paralysis of the face of cortical origin is comparatively rare. It occurred as an isolated paralysis only eight times in 83 cases of facial paralysis, out of a total of 470 cases of skull injury collected by Brun.

4. Association of monoplegia of the face and the arm (forearm muscles predominantly affected), never of the face and the leg (because the centers of the latter two are not adjacent).

5. Association of facial and tongue (motor aphasia) monoplegia. Caution must be employed in diagnosing these cases, because the paralysis of the facial muscles may *per se* interfere with speech. If a true faciolingual monoplegia exists, the tongue points to the paralyzed side.

6. Association of monoplegia of the arm and of the leg. This combination is the most frequent.

The paralysis or paresis and the convulsions of the muscles of the extremities may extend from day to day from one motor center to the other, and thus not all appear at one time. If the paralyses are due to compression from blood-clots, or a depressed fracture, or a splinter of bone, they disappear as soon as the cause is removed. If the paralyses are due to contusion, however, they disappear either gradually or become permanent. If the latter occurs, it may be the beginning of a Jacksonian epilepsy.

II. **Parietal Lobe.**—Lesions of this region cause disturbances of muscle sense. (See foot-note on page 48.)

III. **Frontal Lobe.**—Lesions of the right frontal convolutions more frequently result in psychical disturbances than do injuries of the left side. These occur especially in middle-aged patients who have been drinkers. Such patients in the early days after an injury are apt to be restless, suffer from insomnia, or they are very talkative, or again are apathetic. Later on they suffer from loss of memory, especially of the smaller things of everyday life, and are apt to be very excitable and lack concentration of the mind. In other words, lesions of the frontal lobes with the exception of the motor speech-area, result in disturbances of the higher psychical functions.

IV. **Occipital Lobe.**—Lesions of this part of the brain, including the lobus cuneus and lingual lobule, cause lateral homonymous hemianopsia, *i. e.*, loss of vision in the temporal one-half of the field on the side of the injury, and the nasal one-half of the opposite side. Destruction of the left gyrus angularis causes word-blindness, *i, e.*, inability to see printed speech. Destruction of both gyri angularis or a large lesion of the left one causes mind-blindness (Seelenblindheit), all objects failing of recognition. The cuneus and calcarine fissure (on the mesial aspect of the cerebral hemisphere) together constitute a primary or lower cortical or visuo-sensory center, while the external aspect of the occipital lobe is a visuo-psychic area, containing subareas or centers concerned with higher visual processes.

V. **Subcortical Regions (White Matter).**—Lesions of these portions cause the same symptoms as the corresponding portions of the cortex.

FIGS. 21, 22, 23.—DIAGRAMS ILLUSTRATING THE MORE DEFINITELY LOCALIZED OF THE CORTICAL CENTERS OF THE EXPOSED PART OF THE HEMISPHERE, IN RELATION TO THE MAIN FISSURES AND CONVOLUTIONS; ALSO THE "WORD CENTERS" (SENSORY AND MOTOR) INVOLVED IN THE SPECIAL MECHANISM FOR SPEECH. (RECEIVING SENSORY STATIONS IN BLUE; DISCHARGING MOTOR STATIONS IN RED.) (Harvey Cushing.)

Drawn by accurate orthogonal projection of actual dissection. Note that centers for lower extremity are practically invisible from side and that the best view of the motor field is obtained from above.

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FIG. 21.

FIG. 22.

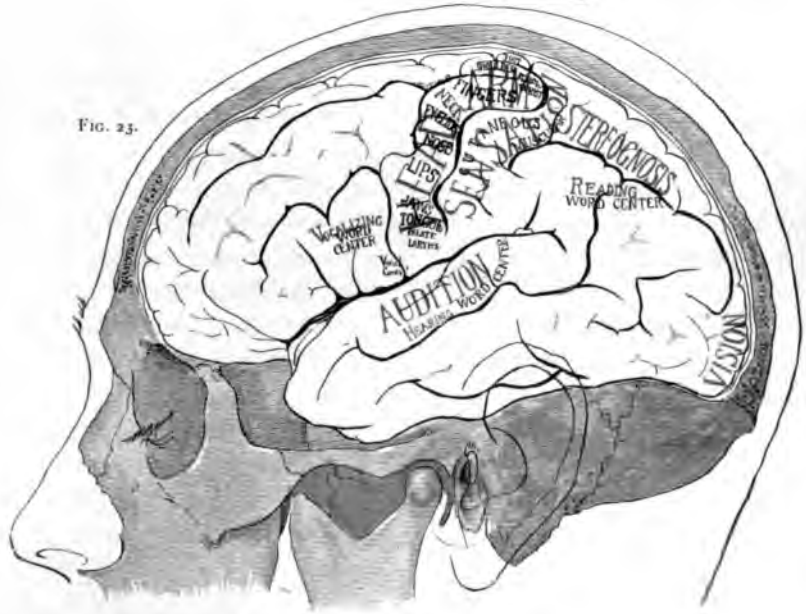

FIG. 23.

VI. **Pons Varolii.**—The symptoms of injury of the pons depend upon whether the lesion is above or below the crossing or decussation of the facial fibers. If it occurs below (lower one-third of pons), it will cause a facial paralysis on the same, and a paralysis of the extremities on the opposite, side (crossed hemiplegia). If the lesion is above the decussation, the face, arm, and leg paralyses are on the same side. There is frequently involvement of the fifth and sixth nerves.

VII. **Speech Region.**—(*a*) *Motor Aphasia.*—The lesion is in the posterior part of the third frontal convolution on the left side in right-handed people. There is an inability to produce articulate speech spontaneously or from dictation. Reading (alexia) and writing (agraphia) are impaired.

One must always be careful to differentiate a difficulty in articulation due to paralysis of the facial muscles from true motor aphasia. The latter rarely occurs as an isolated condition, being usually associated with paresis of the arm muscles. Motor aphasia occurs especially in depressed fractures of the anterior portion of the left parietal and the posterior portion of the frontal bones. It generally disappears in one and one-half to two months.

(*b*) *Sensory Aphasia* (*Word-deafness*).—The auditory center for speech is in the first left temporal convolution in right-handed people. In lesions of this area, there is a loss of memory for word sounds, though the hearing may be undisturbed, but the patient does not understand what is said to him. If the visual speech-center in the gyrus angularis is affected, there is alexia or inability to understand printed words, because here is located the center of memory for printed words, and ordinary sight is undisturbed when there is loss or inability to read or to understand written language.

(*c*) *Visual Aphasia.*—This has been referred to above (page 50). There is word-blindness present, *i. e.*, written symbols, figures, and other conventional signs have lost their significance (Church). When the gyrus angularis alone is affected, there is word-blindness. When the radiations of the optic fibers from the basal ganglia are destroyed, there is hemianopsia in addition.

The center for smell lies in the uncinate gyrus, while that for taste probably lies in the adjacent gyrus fornicatus.

VIII. **Lesions of the medulla** often cause immediate death through paralysis of the vagus nuclei. There may also be many symptoms of injury to the medulla should the patient survive, such as diabetes,

albuminuria, polyuria, singultus, bulbar symptoms, and inflammatory conditions of the lungs. The latter are the second most frequent cause of death in the first days of the injury, the most frequent being contusion of the vital centers in the medulla.

IX. **Cerebellum.**—Injuries of this part of the brain cause ataxia, incoördination, muscular weakness, nystagmus, and vertigo. Irritative

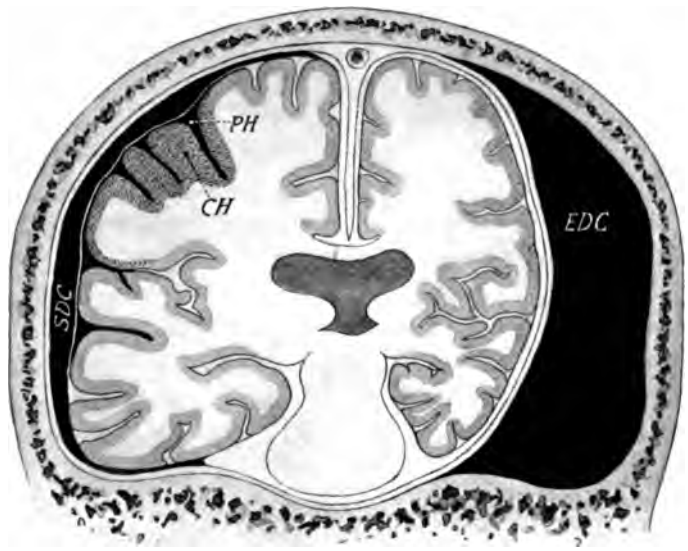

FIG. 24.—DIAGRAMMATIC REPRESENTATION OF VARIOUS FORMS OF INTRACRANIAL HEMORRHAGE. *EDC*, Epidural clot, most frequently due to rupture of middle meningeal; *SDC*, subdural hemorrhage; *PH* hemorrhage into the piaarachnoid; *CH*, hemorrhages into the cortex.

lesions cause muscular stiffness on the same side of the body and arching of the spine (opisthotonos).

INTRACRANIAL HEMORRHAGE.

In examining a patient for the purpose of making a diagnosis of whether an injury to the skull or brain has been complicated by intracranial hemorrhage, one must take into consideration the various sources from which it can arise, and their symptoms.

Intracranial hemorrhage of traumatic origin can occur from the following structures:

1. ***From the Trunk or One of the Branches of the Middle Meningeal Artery.***—This hemorrhage takes place between the internal table and

the outer layer of the dura and is known as an extradural or epidural hematoma (Fig. 24). It is usually called "middle meningeal hemorrhage" in practice, because this artery is torn, as a rule. Injuries of the arterior and posterior meningeal arteries are quite infrequent. In many cases there is an accompanying laceration of the dura, so that the blood also escapes into the subdural space, causing a bilocular or hourglass hematoma. The most frequent cause of a tear of the trunk of the middle meningeal artery is a fracture of the vertex, extending into the base. The artery may, however, be torn without a fracture. The point of impact of the force is of value because the hemorrhage is usually directly under it, and one should at once search for local evidences of injury of the scalp and skull in order to aid in diagnosing the side upon which the hemorrhage occurred.

2. *From the Vessels of the Piaarachnoid.*—The blood either remians in the sulci (Fig. 24), beneath the unbroken pia mater, or it escapes into the subdural space and collects especially at the base of the brain. This form of hemorrhage is known as a subdural and is often spoken of as "intermeningeal," because the blood lies in the subdural space between the dura mater and the piaarachnoid.

There are many cases of middle meningeal hemorrhage in which the dura is torn so that the blood escapes into the subdural space, as well as into the epi- or extradural space. Clinically it is impossible to differentiate such a bilocular hemorrhage from a pure epidural one.

3. *From the Venous Sinuses.*—Those most often injured are the longitudinal, the lateral, and the cavernous sinuses. Of these, the longitudinal is the most frequently involved,[1] being torn by a fracture of the vertex or penetrated by a bullet or some blunt instrument. The lateral sinus is injured in a similar manner, although cases are recorded in which it has been torn without an accompanying fracture of the skull.

The cavernous sinus is usually torn in fractures of the anterior and middle fossæ of the base. A laceration of the cavernous sinus is comparatively rare. It occurs most often in conjunction with an injury of the internal carotid artery, resulting in the formation of an arteriovenous aneurysm whose most prominent symptom is a pulsating exophthalmos. (See page 34.) It is well to mention again that cases of this form of injury to the sinus and artery have occurred without a fracture of the base.

4. *Injuries of the Intracranial Portion of the Internal Carotid and of the Vertebral Arteries.*—Laceration and escape of blood into the

[1] In 70 cases collected by Wharton, the longitudinal sinus was involved in 40, the lateral in 26, the cavernous in 3, and the straight in 1.

interior of the skull may occur from injury of either of these vessels, for example, as a result of gunshot wounds. Fortunately, however, they are of rare occurrence. Death occurs before a diagnosis can be made.

It may be of some interest in connection with the diagnosis of intracranial hemorrhage to state that Chipault, out of 117 cases of intracranial hemorrhage, found 72 to be from the middle meningeal arteries and 30 from the sinuses. Treves believes that 80 to 85 per cent. of all intracranial hemorrhages are due to injury of the middle meningeal artery.

1. **Diagnosis of Middle Meningeal Hemorrhage.**—As was stated on page 38, *the symptoms of middle meningeal hemorrhages are those of the cerebral compression which it produces*. We must watch for these in every case of cerebral injury in which either the patient does not recover within a reasonable period from the symptoms of concussion which appeared immediately after the injury occurred, or he becomes drowsy, stuporous, and gradually comatose after a period of consciousness. This free interval may either follow the symptoms of concussion or the latter may have been so slight that the patient or his relatives paid no attention to them until those of compression began to appear. According to some, this free interval is absolutely diagnostic of middle meningeal hemorrhage, and it is well to remember that this is the most typical manner in which it occurs. But one must not overlook the fact that there may be no free interval or that there is often no history obtainable of a period devoid of symptoms of compression. The hemorrhage usually occurs from the trunk of the middle meningeal artery alone, under which conditions the hemorrhage is quite profuse, and a frequently accompanying tear of the dura

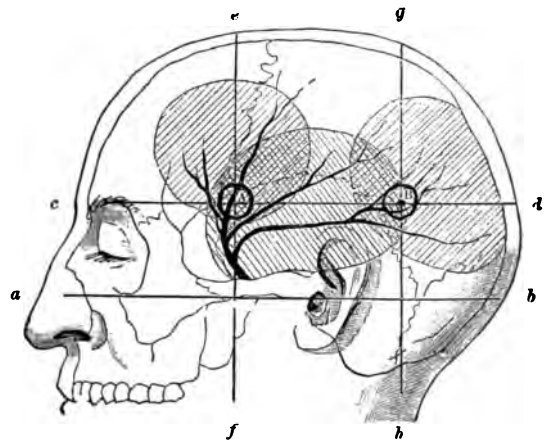

FIG. 25.—SITE OF TREPHINE OPENING TO REACH CLOT IN HEMORRHAGE FROM MIDDLE MENINGEAL ARTERY (Krönlein).

a, *b*, Horizontal line through the meatus; *c*, *d*, on a line with the eyebrows; *e*, *f*, vertical line 3 to 4 cm. behind the ext. ang. process; *g*, *h*, at the posterior border of the mastoid process. A, the point to reach the anterior, and B, the posterior branch.

permits the blood to escape into the subdural space as well as into the epidural. In general it may be said that the lower down the artery is torn the more rapidly do the symptoms appear.

If either the anterior or posterior branches are torn, a clot forms at the corresponding part of the extradural space, compressing the underlying brain (see Fig. 24). In infants, the blood from a torn middle meningeal artery may escape through the opening in the skull caused by the fracture and collect beneath the scalp, forming an enormous cephalhematoma which does not have the suture lines as its boundaries. Cephalhematomata arising during parturition, or later as a result, have the suture lines as their boundaries (page 19).

If the symptoms of compression appear immediately after the injury, they are most likely due to a depressed fracture; if they appear after a few hours, they are due to hemorrhage. If they appear after thirty-six to forty-eight hours, they may be due to some infective complication. The diagnosis of middle meningeal hemorrhage can be made from the following history: Immediately after the injury the patient either becomes unconscious and shows the signs of concussion or contusion (see page 43). Instead of recovering consciousness, the coma grows deeper, the respirations, instead of being weak and slow, become stertorous, the pulse, which was of low tension and slower than normal, becomes firm, its tension is greatly increased and it is very slow, often sinking to 40 or 50. The blood-pressure, which was but slightly increased by the concussion, becomes quite high. If the clot presses on the so-called silent area of the cortex, there are no focal symptoms, but if there is pressure over the motor area (Fig. 23), there are at first twitchings in the muscles corresponding to the compressed motor centers, followed by paresis or paralysis of the facial muscles, of the muscles of the arm, and of those of the leg on the side of the body opposite to that of the lesion, also called contralateral monoplegia or hemiplegia. The paralysis of a middle meningeal hemorrhage is complete; that due to a contusion of the brain is only partial. Both forms are often accompanied or preceded by twitchings or convulsions of the affected muscles, but this is more characteristic of compression.

If the patient does not show the above-mentioned symptoms immediately after those of the primary concussion, they may appear after a short interval. Again, a man or woman may appear perfectly well after a fall on the head or a scalp wound, and have been dressed by a physician who has made a diagnosis of fissured fracture of the vertex or of fracture of the base without complications. A few hours later the patients become irritable and restless, the pulse becomes slower, they

cannot be aroused, and the typical symptoms of compression appear. In addition to these general and focal brain symptoms one can often find as an aid to the diagnosis a tenderness, or a hematoma, or at times an ecchymosis over the temporal bone on the same side as the intracranial hemorrhage. The latter signs are due to the escape of blood through the gap in the bone. There are many atypical cases of middle meningeal hemorrhage. The free interval is often absent, especially in elderly people, in whom the signs of concussion and contusion are of longer duration. The hemiplegia may at times be on the same side as the hemorrhage (collateral). The choked disc has often disappeared by the time the patient is seen. The condition of the pupils is often unreliable. The slow pulse may be absent or be masked by the presence of fever which causes an increase in its rapidity. The respiration is also normal at times. Both slow pulse and respiration are only of value if they are present. If the patient is seen in the terminal or paralytic stage of compression, both pulse and respiration may be quite rapid. The most valuable signs in cases where a lucid interval has existed are (1) the disturbances of the sensorium, *i. e.*, irritability or delirium followed by stupor and coma; (2) gradual slowing of the pulse and respiration; (3) increase in blood-pressure; (4) signs of local pressure, viz., twitchings followed by paralysis of the contralateral type.

FIG. 26.—FIRST STEP IN DETERMINING THE POINT TO MAKE A LUMBAR PUNCTURE.

C, C, Tape-measure resting upon highest point of the crests of the ilia; P, P, posterior superior spines of the ilia; III, IV, and V, spines of the third, fourth, and fifth lumbar vertebræ; L, L, indicate two points lateral to the median line of the spine in third interspace, where needle is usually inserted.

2. **The diagnosis of an intermeningeal or subdural hemorrhage** in children and adults cannot be made with any degree of exactness. In general it may be said that the symptoms of compression are much less marked than in middle meningeal hemorrhage, and are *slower in onset.* The free interval is usually longer and the signs of compression are more general than focal. In some cases lumbar puncture has been performed and the cerebrospinal fluid thus withdrawn found deeply stained by blood (Figs. 26, 27). This means of diagnosis need, however, seldom be resorted to. In subdural hemorrhages, cortical centers quite widely separated are often involved. The temperature is more uniformly high on account of the invariably associated contusion. If the hemorrhage occurs chiefly into the piaarachnoid and into the cortex, the symptoms, such as convulsions, cannot be distinguished from those of contusion. In newborn infants subdural and pial hemorrhages cause tense fontanelles, asphyxia, and convulsions. These may not appear until several days after birth.

FIG. 27.—METHOD OF PERFORMING LUMBAR PUNCTURE.

P, Posterior superior spines of the ilia; C, uppermost level of crest of ilium; III, spine of third lumbar vertebra; IV, spine of fourth lumbar vertebra; V, spine of fifth lumbar vertebra. The needle is directed to the third lumbar interspace, a little lateral to the median line. (See text.)

3. **Hemorrhage from the Venous Sinuses.**—Of the three principal varieties of traumatic intracranial hemorrhage, that from the sinuses causes the least degree of compression and can be recognized from the extreme slowness of the onset of the symptoms. The diagnosis depends upon the situation of the wound or fracture, upon the mild compression symptoms, and in the case of the longitudinal

sinus, upon the escape of considerable blood from a wound in close proximity to the sinus. Focal symptoms are usually absent.

Hemorrhage from the intracranial portion of the internal carotid causes almost immediate death.

4. **Late Traumatic Apoplexy.**—A number of cases have been reported in which symptoms of cerebral apoplexy have appeared after a clear interval of days to weeks, the longest period being four weeks (Stadelmann) after an injury to the head. The question of whether these are due to trauma has come to be of considerable medicolegal interest. The symptoms of compression are the same as those due to extra- or subdural hemorrhage, the only difference being that the clot lies beneath the cortex, either in the white matter or in the internal capsule.

The question arises, Can these late hemorrhages be ascribed to the injury? A number of articles[1] have appeared, and the majority of writers believe that the injury merely plays the part of an exciting cause in a person predisposed by reason of some vascular weakness due to alcoholism, nephritis, syphilis, or cardiac disease.

DIFFERENTIAL DIAGNOSIS OF INJURIES OF THE BRAIN.

	Concussion.	Contusion.	Compression.
Time of onset of symptoms	Immediately after accident.	Immediate, but symptoms usually obscured by those of concussion or compression.	After free interval, unless due to depressed fracture. (See page 38.)
General cerebral symptoms	Loss of consciousness for some minutes to hours. Vomiting.	Delirious unless complicated by concussion or compression.	Restlessness, apathy, stupor, gradually changing to deep coma in hemorrhage. Immediate unconsciousness in majority of depressed fractures.
Focal symptoms	None, unless complicated by contusion or compression or injury to cranial nerves.	Localized or general twitchings and convulsions, accompanied by pareses or paralyses. May have aphasia if third left frontal convolution is involved.	Localized (face or arm or leg) twitchings and convulsions precede paralysis (usually in form of mono- or hemiplegia). Convulsions less frequent in hemorrhage than in contusion.
Pulse	More rapid as a rule than normal. No increase in tension.	No change, unless medulla affected, then indistinguishable from paralytic stage of concussion and compression except by earlier onset of rapid feeble pulse.	Slow (40 to 60) and of high tension, unless fever present, then rapid.
Respiration	Slower than normal.	Same as above true for respiration	Slower and deeper (stertorous). May be of Cheyne-Stokes type.
Blood-pressure	Slight rise.	No change.	Gradual rise as intracranial tension increases.
Pupils and eyeball	May be dilated or contracted	No change unless occipital lobe involved (homonymous hemianopsia).	Pupils usually unequal. Dilated on side of injury, with conjugate deviation of eyeball. Choked disc, usually transitory.
Temperature		Quite high and of continuous type.	Usually rises as pressure increases, but not as high as in contusion.
Lumbar puncture	Negative.	Usually some blood.	Blood, if intermeningeal hemorrhage, *i. e.*, into subdural space.

[1] Colley, "Deutsche Zeitschrift für Chirurgie," vol. lxix; Marie, "Revue de Médecine," May 10, 1905.

DIFFERENTIAL DIAGNOSIS OF INJURIES OF THE BRAIN.—(*Continued.*)

	Concussion.	Contusion.	Compression.
Variety of force....	Usually diffuse.	After circumscribed or diffuse.	Diffuse in hemorrhage (extension of fissure to base). Circumscribed in depressed fractures.
Course.....	Symptoms gradually decrease and recovery, or symptoms of contusion or compression appear, or death ensues.	Signs of localized injury usually disappear. Very few become permanent.	Coma, etc., increase, and paralytic stage sets in unless relieved.

PACHYMENINGITIS HÆMORRHAGICA INTERNA.

This condition not infrequently follows an injury to the head in adults, as well as in children. In the former it occurs especially in alcoholics, and more particularly in middle-aged or older men. In a typical case one can get the history of an injury, followed by attacks of coma and paralysis, which entirely disappear, but recur after a variable interval of time. During these attacks the patient complains of headache, is drowsy, and soon becomes comatose. There is paralysis of one or both sides of the body, accompanied by exaggeration of the tendon reflexes, contractures, and clonic or tonic convulsions. The pupils are normal, or are contracted on one or both sides. In the interval between the attacks the patients usually complain of vertigo, are easily fatigued, show psychical disturbances, such as apathy and loss of memory, and there are evidences of pareses and paresthesia.

The differential diagnosis must be made from purulent leptomeningitis, in which there is stupor followed by coma, ocular paralysis, unequal pupils, and rigidity of the neck. There is also always fever present, as well as a rapid pulse, which is not true of pachymeningitis hæmorrhagica, unless there is an accompanying pneumonia. Furthermore, lumbar puncture shows the presence of pus in purulent leptomeningitis.

From sinus thrombosis, it can be differentiated by the presence of a cause for the thrombosis, and repeated chills, followed by rises of temperature, sweats, and early evidences of metastases.

From intracerebral hemorrhage, it is almost impossible to make a diagnosis during the attack, except that there is greater restlessness and delirium in pachymeningitis hæmorrhagica. The presence of epileptiform convulsions and contractures and the recurrence at intervals speak for pachymeningitis hæmorrhagica.

It can be differentiated from tumors of the brain by the presence of more circumscribed headache and marked choked disc, as well as more marked focal symptoms in a tumor.

From abscess of the brain it can be distinguished by the etiology and the more frequent presence of a choked disc in abscess.

INTRACRANIAL SUPPURATION FOLLOWING INJURIES.

The symptoms of infection usually appear within thirty-six to forty-eight hours after the injury. This is the case with infections of the meninges, while those of the brain proper and of the venous sinuses appear a little later. Symptoms of infection may, however, not show themselves in the form of a chronic encapsulated abscess of the brain, until years have elapsed, and under these conditions the relationship between the injury and the cerebral abscess may be difficult to trace.

I. **Epidural Abscess or Purulent Pachymeningitis.**—The symptoms of a circumscribed collection of pus lying between the dura and the skull do not differ from those which are observed in cases where the pus lies in the subdural space, and the diagnosis will be considered in conjunction with the latter form. The only difference between the epidural and subdural posttraumatic abscesses is that in the former the external wound is much more apt to present the evidences of an acute infection in the shape of swelling, redness, and tenderness of the scalp, foul odor of the pus, and unhealthy appearing granulation-tissue. Such circumscribed collections of pus, in either the epi- or subdural spaces, most frequently complicate fractures of the vertex, especially of the depressed or punctured variety. Basal fractures are more often followed by meningitis of a diffuse character. Epidural abscesses occurring from causes other than trauma, such as osteomyelitis of the cranial bones, infections from the frontal, sphenoidal, or ethmoidal sinuses, and from middle ear, and mastoid disease, differ only in their history from the traumatic variety. The diagnosis in both the traumatic and nontraumatic varieties can be made: (1) From the history of the injury or disease preceding the abscess. (2) From the appearance of the wound or diseased area in the skull. (3) From the presence of general symptoms of compression, such as somnolence, slow pulse, pain, choked disc, and fever. (4) Focal signs. These are rarely found except in children.

II. **Subdural Suppuration or Purulent Leptomeningitis.**—On account of the frequent involvement of the superficial portion of the brain in suppurative inflammation of the piaarachnoid, this form of infection has been given the name, by some writers, of meningoencephalitis (Koenig), and by others, of traumatic leptomeningitis (von Bergmann). Subdural suppuration may occur in either a circumscribed or

diffuse form. As is stated above, the localized form is more apt to follow fractures of the vertex and give rise to focal symptoms, but both the circumscribed and diffuse forms may follow fractures of the base.

The diagnosis of an infection of the piaarachnoid following injury depends upon the recognition of certain symptoms of cerebral irritation, followed by those of coma. This condition of leptomeningitis should be suspected in every case of compound fracture, either of the base or vertex, but especially of the former, when the symptoms of concussion, contusion, and compression having either disappeared or improved, the patient begins to complain of persistent headache, or is delirious, restless, drowsy, with rapid pulse, contracted pupils, and a gradually rising temperature of a continuous type. There may also be nausea and vomiting of the projectile variety. At the same time, there are certain local signs of wound infection, such as abundant secretion of pus and angry appearance of the edges. Within a few hours this first or stage of cerebral irritation is followed by the second or paralytic stage. Aside from the presence of fever and the appearance of the wound, the symptoms in the first or stage of irritation are somewhat similar to those of the stage of reaction in concussion cases, which occurs at about the same period after the injury—thirty-six to forty-eight hours. The rapid rise of the pulse-rate (80 to 100) the gradual rise of blood-pressure, the presence of fever (101 to 103°), and the severity of the headache, are quite characteristic of a meningeal infection. The second stage soon clears up any doubts. The patient gradually becomes comatose, and there are signs of a marked increase in the intracranial tension.

The irritation of the cortex by the accumulation of pus either in the subdural space or meshes of the piaarachnoid shows itself in the form of localized or generalized muscular twitchings accompanied by tonic and clonic convulsions. These may be uni- or bilateral.

Pressure on the cortex causes paralyses of the face, arm and leg or monoplegias according to the area affected (Fig. 23).

When the accumulation of pus is especially marked at the base of the brain, as happens most frequently after basal fractures, there are scarcely any cortical symptoms. Early rigidity of the neck, evidences of pressure on the cranial nerves at the base, such as strabismus and disturbances of respiration, like the earlier appearance of the Cheyne-Stokes type of breathing, lead one to suspect the predominance of a basal meningitis. The respiration is rapid as a rule, unless the infection involves the cerebellar fossa. The temperature is of the continuous type and high.

True optic neuritis with choked disc, gradual rise in the blood-

pressure as the pus accumulates, slow, high-tension pulse, and slow, often irregular, respiration (through stimulation of the vagus), are all characteristic of this second or paralytic stage of meningeal infection.

The condition of the wound in cases of fracture of the vertex is similar to that described above in the initial stage of the infection. Not infrequently there is a prolapse of the brain (secondary hernia cerebri) as a result of the increased intracranial tension, through the opening in the vertex (see page 68).

In some cases, lumbar puncture has been resorted to; the presence of pus in the spinal fluid confirms the diagnosis of a leptomeningitis.

III. **Serous Meningitis.**—This was first described by Quincke. It is due to an excessive subarachnoid collection of fluid. The symptoms are quite similar to those of the purulent form, but the fluid obtained by lumbar puncture is clear and sterile. Recovery is the rule and not the exception as in the purulent form.

IV. **Abscess of the Brain.**—This form of intracranial infection is far more frequent after fractures of the vertex than after those of the base. The abscess is found close to the most frequent seat of fracture, hence close to the parietal bones. Abscess of the brain may occur without any fracture of the skull in an area of contusion of the cerebrum. McEwen has shown that abscess of the brain, whether following a compound fracture or occurring as a complication of middle-ear disease, or from any cause other than metastasis from pulmonary conditions, is always contiguous to the atrium of infection. About 50 per cent. of all brain abscesses are the result of trauma. Of the remainder, those due to middle-ear or mastoid disease form the majority. Other forms are either metastatic (pyemic or after-pulmonary gangrene) or due to extension from the ethmoid, sphenoid or frontal sinus.

Posttraumatic abscess of the brain may occur either in an acute form, that is, within five to six days after the injury, or in a chronic form. In the latter, the symptoms may not show themselves until years after the injury. The symptoms of both forms are the same, the only difference being in their time of appearance.

The *diagnosis of acute traumatic abscess* depends upon the appearance of certain general and focal signs of infection which begin at the end of the first week following the injury. The *general signs* are (1) great mental depression or irritability accompanied by severe headache; this is followed by stupor and coma; (2) local tenderness on tapping the skull over the seat of the injury; (3) slow pulse and respiration, the pulse sinking to 60 or lower. The respiration may be irregular, even Cheyne-Stokes in character. This latter type is especially likely to

be the case in abscesses of the cerebellum. (4) Papillitis and choked disc are not constantly present. Their absence will not exclude the presence of a cerebral abscess. (5) The temperature is usually elevated, but there may be no fever. (6) *Focal symptoms*—these will vary according to the location of the lesions and consist of convulsions and paralysis, or symptoms of aphasia, etc. There may be localized twitchings with convulsions of the muscles of one extremity or of the entire opposite half of the body. The extent of the paralysis is not always a criterion of the amount of destruction of the cerebral tissue, owing to the fact that many symptoms both of irritation and paralysis are due to inflammatory edema in the neighborhood of the focus of suppuration called by German surgeons "Fernwirkung." Aphasia may be present in connection with the paralysis of the extremities, although this is less frequent after traumatic than after otitic infection. In abscesses of the cerebellum there are, in contradistinction to those of the cerebrum, a few more distinctly localizing symptoms. These are rigidity of the neck, occipital headache, cerebellar ataxia, and at times marked vertigo and vomiting. (7) The appearance of the wound—there is an increased amount of suppuration from the wound, the edges look angry, and the granulation-tissue edematous.

The *differential diagnosis of an acute traumatic abscess*, must be made from the following: (*a*) From epidural abscess, in which the general pressure symptoms are far less marked,—there are no focal symptoms as a rule and the temperature is usually higher; (*b*) from a purulent leptomeningitis,—the differentiation cannot be made for the reason that the symptoms of the meningitis usually obscure those of the abscess; (*c*) from sinus thrombosis,—this form of infection is comparatively rare after fractures of the skull, usually involving only the longitudinal sinus. A septic sinus thrombosis can be distinguished readily from cerebral abscess by the frequent occurrence of chills followed by the characteristic steeple-like rise of temperature and followed by sweats as well as by the evidences of pulmonary metastasis.

The *chronic traumatic abscess* can only be distinguished from abscesses of the brain due to other causes by the history of a preceding trauma sufficient to permit of the invasion of the interior of the cranium by microörganisms. Often the only symptoms observed at the time of injury are those of cerebral contusion, from which the patient fully recovers. After a long period of latency in which apathy, melancholia, headache, and emaciation are present, three groups of symptoms begin to show themselves; (*a*) those due to the infection, such as slight rise of temperature, lack of appetite, muscular weakness, etc.; (*b*) the signs of

increased intracranial pressure, such as mental depression or irritability, headache, increased by exertion or upon tapping the skull over the seat of the abscess, vomiting, stupor and choked disc, slow pulse, and increase of blood-pressure. Choked disc is less constant in an abscess of the brain than in tumor; (*c*) the focal symptoms, which vary according to the seat of the abscess in the same manner as in the acute form and consist

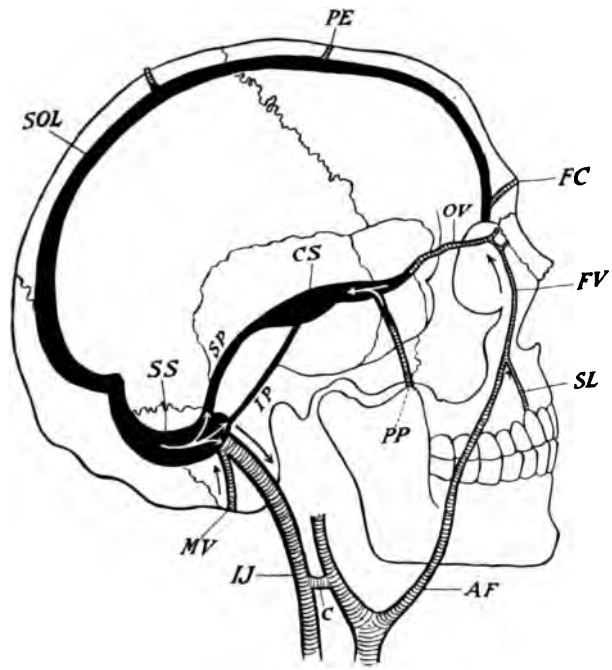

FIG. 28—MODES OF TRANSMISSION OF INFECTIVE THROMBOSIS ALONG THE ENDOCRANIAL SINUSES.

SOL, Superior longitudinal sinus; *PE*, parietal emissary vein; *SS*, sigmoid sinus. The white arrows point to the three directions in which infection may be transmitted from this sinus along the superior petrosal (*SP*), the inferior petrosal (*IP*), and internal jugular (*IJ*). *MV*, Mastoid emissary vein, along which infection may be transmitted in the direction of the black arrow to sigmoid sinus· *CS*, cavernous sinus. The white arrow shows the direction of transmission of infection from the pterygoid plexus of veins (*PP*), and ophthalmic vein (*OV*). *FC*, Vein passing through foramen cecum into longitudinal sinus; *FV*, communication of facial (*FV*) and veins of upper lip (*SL*), with ophthalmic vein and cavernous sinus; *AF*, anterior facial vein; *C*, communication between the external and internal jugular veins.

of general or localized epileptiform convulsions, hemiplegia, and similar focal signs.

The differential diagnosis of chronic traumatic abscess must be made principally from tumor of the brain (see page 88).

Sinus Thrombosis.—Infective thrombosis of the intracranial sinuses is comparatively rare after injury to the scalp or skull. It can occur after erysipelas or phlegmon of the scalp, following infected

wounds of the scalp, or compound depressed or punctured fractures of the vertex. The sinus most frequently affected after injury is the longitudinal.

The diagnosis can be made, first, by considering the nature and position of the injury and, second, the possibility of infection having traveled either by way of the lymphatics or veins, through the skull into the sinuses. The manner in which this occurs can be readily understood by a reference to Fig. 28, which shows how infection of the superficial veins of the scalp or skull can by progression of the thrombotic process be transmitted to the sinuses into which these veins empty.

The second point in diagnosis is to observe the local signs of infection of particular endocranial sinuses. This is fully considered on page 94, in connection with otitic sinus thrombosis.

Thirdly, the general evidences of infection, usually of a pyemic character. The pulse is rapid. The temperature is of a remittent type, severe chills occur at irregular intervals, followed by high temperatures and sweats. The patient usually suffers from severe headache, either diffuse or circumscribed. The mind is clear unless there is a complicating meningitis or abscess.

The spleen is frequently enlarged, and following every chill there are evidences of fresh metastases. The majority of the latter are pulmonary, in the form of miliary or somewhat larger abscesses which give rise to the symptoms of pleurisy or, if they break into the pleura, of pyopneumothorax.

There is a second clinical type of thrombosis known as the typhoid or septicemic form. It occurs more frequently after sinus thrombosis complicating middle-ear disease and will be referred to later (page 94).

DIFFERENTIAL DIAGNOSIS OF INTRACRANIAL INFECTION FOLLOWING INJURY.

	Meningitis.	Cerebral Abscess.	Sinus Thrombosis.
Time of onset of symptoms..	Thirty-six to forty-eight hours after injury.	Either toward the end of the first week (early or acute) or after some months or years (late or chronic form).	Usually toward end of first week.
General cerebral symptoms.....	Severe headache, delirium, restlessness, stupor gradually changing to coma. May have nausea and vomiting.	Headache often more localized than in meningitis. Drowsiness followed by coma.	Clouded mental condition, but brighter than in meningitis or abscess unless these are present.
Focal symptoms...	Localized and generalized (more marked) twitchings and convulsions if on convexity. Paralysis of cranial nerves especially ocular and facial if basal.	Majority of the posttraumatic abscesses close to motor region, hence localized twitchings and paralysis of mono- or hemiplegic type. Often speech and visual disturbances. (Distant action.) All focal symptoms more marked than in meningitis.	No cerebral focal symptoms. For local signs of thrombosis of individual sinuses see page 94.
Temperature.....	High and usually of continuous type. (101–103° F.)	Usually fever, but not high.	Irregular chills followed by very high fever and sweats.

DIFFERENTIAL DIAGNOSIS OF INTRACRANIAL INFECTION FOLLOWING INJURY.—(*Continued.*)

	Meningitis.	Cerebral Abscess.	Sinus Thrombosis.
Pulse	Rises as symptoms increase, usually is 80 to 100.	Becomes slower as abscess grows.	More rapid than in abscess, rises greatly during and after chills and as disease progresses.
Respiration	At first more rapid than normal but becomes slower as exudate increases and again faster during terminal or paralytic stage.	Slower, often irregular and of Cheyne-Stokes type.	Becomes quite rapid as evidences of pulmonary metastases begin to show themselves.
Blood-pressure	Rises gradually as exudate increases.	Marked rise as intracranial tension increases.	Slight rise.
Eyes	Paralyses of ocular muscles especially marked in basal meningitis. (Ptosis, dilated pupils, strabismus, etc.) Rarely have optic neuritis or choked disc.	Depends on location. If close to occipital lobe (homonymous hemianopsia). Optic neuritis and choked disc seldom well marked.	Rarely any changes in eye except in cavernous sinus thrombosis.
Lumbar puncture	Turbid fluid.	Negative.	Negative.
Condition of wound	If on convexity granulations edematous, wound edges swollen, reddened, tender and often necrotic.	Same as in meningitis, considerable pus discharged from wound.	Same as in meningitis.
Course	Death in a short time (1 to 2 weeks) after onset.	Recovery in majority if operated on and no complicating sinus thrombosis or meningitis. If not operated pus escapes into ventricles or subdural space.	Death from pulmonary complications.

CONTUSIONS OF THE CRANIAL BONES.

These, like fractures, may be either simple of compound. The diagnosis of their presence in either case can be made only from inspection of the wound and from the presence of intracranial injury and abscess formation without fracture of the skull. Their occasional resemblance to a fracture if filled with dirt or hair has been referred to on page 25.

HERNIA CEREBRI.

Hernia cerebri is the term given to a prolapse of the brain which may either immediately follow an injury or be the result of greatly increased intracranial pressure, such as (*a*) occurs from infection of the meninges or brain following an injury, or (*b*) the presence of a tumor within the cranial cavity.

The diagnosis of a primary hernia cerebri can be made from the protrusion, through a wound in the skull, of brain substance. If there is any question at the time of injury as to whether the protruding substance is brain, an examination of the material will show ganglion cells.

The diagnosis of a secondary hernia cerebri (Fig. 29) can be made from the presence of a soft mass which protrudes through the gap in the skull and pulsates synchronously with the heart. It is irregular and red or dark in color. After a short period the surface becomes necrotic, of a grayish color, has a foul odor, and bleeds easily, so that after a few

days all of the brain tissue has sloughed away, leaving simply a bleeding mass of granulation-tissue. Pressure on this soft tumor causes symptoms of intracranial pressure.

TRAUMATIC EPILEPSY.

The diagnosis of traumatic epilepsy depends upon a careful analysis of the following factors: First, an accurate history of a recent or old trauma to the skull; second, the objective examination of the scalp and skull for evidences of the injury—this is best conducted when the scalp is shaven, and in all doubtful cases this should be done; third, a careful study should be made of the mode of onset, of the form of the twitchings or convulsions, whether tonic or clonic in character, and of the distribution of the twitchings or spasms; fourth, every effort should be made to exclude the possibility of the epileptiform seizures being of the non-traumatic variety.

FIG. 29.—SECONDARY HERNIA CEREBRI FOLLOWING COMPOUND FRACTURE OF THE FRONTAL BONE IN A BOY OF EIGHT. (Dr. L. A. Greensfelder's case.)

In connection with the first factor, one should ascertain as closely as possible the symptoms following the injury which has been suspected to have produced the epilepsy. In many cases one can get a history of a compound fracture, frequently of the depressed variety, in which after relieving the depression the fragments were replaced.

Again one can secure the history of symptoms of intracranial injury severe enough to have been produced by a fracture of the skull, in which no operative interference took place, so that it is proper to assume that the epileptiform convulsions are due to a non-corrected depressed fracture. This latter conclusion is corroborated if the objective examination of the scalp shows a distinct depression at the site of injury.

One should always examine the scalp and skull for scars and for areas of depression in the skull. The absence of scars or depressions in the skull does not exclude the possibility of the epileptiform seizures

being due to an injury, since traumatic epilepsy follows non-depressed fractures as frequently as it does depressed ones.

One should also examine the patient further to ascertain whether scars or neuromata at other portions of the body than the head could be the starting-point of the convulsions, since it is well known that such scars or neuromata on the trunk and limbs may act as irritants sufficient to produce epileptiform convulsions.

The history and objective examination are further of value in cases where an operation has been performed on the skull or brain, for the removal of tumors, drainage of abscesses, etc.

Traumatic epilepsy generally begins in one group of muscles, and extends to adjacent areas of the cortex, in a definite order. Which centers are first affected depends entirely, in the case of bone, dural, or cortical changes, upon the situation of such lesions. The onset of the convulsions may be preceded by an aura which consists of pain in the scar or of numbness in the affected muscles.

In a typical case of traumatic epilepsy the convulsions are Jacksonian in character. They are at first clonic, and then tonic, in character, followed by more or less stupor and coma, and by temporary paralysis in the affected muscles. Rarely do the convulsions travel to the opposite side of the body, although there are cases in which the convulsions are general from the very beginning of the disease.

In the differential diagnosis one must exclude cortical irritation, due to tumor or abscess of the brain. One must also exclude the epileptiform seizures following infantile or adult hemiplegia. Again, there is a so-called form of non-traumatic Jacksonian epilepsy which can be readily differentiated by the absence of the history of trauma or of any objective evidences of the same. In the common or essential non-traumatic epilepsy in which generalized convulsions occur, the onset of the convulsions is usually preceded by an aura and there is no history of trauma. This latter condition has also usually existed from infancy.

MENTAL CONDITIONS FOLLOWING CRANIAL INJURY.

The diagnosis of whether a disturbed mental condition is a direct sequence of an injury is difficult to say, for the reason that in many cases the symptoms may not appear until months or years after the injury, which may have been a slight one. In general, one may speak of primary conditions which directly follow the injury, and of secondary or late sequelæ. The primary conditions most frequently found are, first, defective memory, and, second, recurrent headache. In regard to the

former, it may disappear, or remain as a permanent condition. There is often a marked loss of memory, or the patient only forgets the common things of everyday life. Not infrequently the musical and arithmetical faculties are lost, and there is a lack of concentration of the mind.

The third symptom of psychical change is greater irritability. Vertigo is often quite marked, especially on bending forward. Not infrequently other mental symptoms may follow the injury, especially if there has been contusion of the frontal lobes. These are delirium, restlessness, hallucinations, and insomnia. These latter symptoms disappear within two or three weeks after the injury, but leave a state of greater mental irritability, so that the patient is not able to resume his ordinary occupation for some time.

The late traumatic mental changes may be divided, according to Krafft-Ebing, into three groups. In the first the patients gradually become feeble-minded and idiotic, and associated with this condition there are disturbances in coördination and paralysis. In a second group the psychical disturbance develops after a long prodromal stage, in which mental irritability and change of character of the patient are noticed. These are followed by maniacal conditions, or by progressive paralysis. In a third group, the trauma seems to have only an indirect influence, affording a certain predisposition to the mental disease, which develops as the result of other accompanying causes.

INJURIES OF THE HEAD IN THE NEWBORN.

Cushing,[1] Seitz[2] and Carmichael have directed attention to the necessity of making a special study of these injuries. The caput succedaneum, cephalhematomata and fractures of the skull in the newborn were referred to in the first part of this chapter.

Intracranial hemorrhages are quite common after long labor in a rigid or narrow pelvis or after instrumental delivery. The bleeding is usually subdural or cortical. It varies greatly in extent and may be present on one or both sides. The principal symptoms are those of a gradually increasing pressure, such as slow pulse and respiration, twitchings, convulsions and paralyses. Asphyxia is a quite prominent symptom and there is usually subconjunctival hemorrhage, and edema of the eyelids. Blood is found in the lumbar puncture. Bärensprung and Cushing believe that nevi on the face are due to hemorrhages into the Gasserian ganglion. The sequela of intracranial hemorrhage are permanent paralyses and defective mental development.

[1] Keen's "System of Surgery," vol. iii.

[2] "Progressive Medicine," vol. i, 1908.

DISEASES OF THE SCALP, SKULL, AND BRAIN.

DISEASES OF THE SCALP.

INFECTION.

The most frequent variety of infection of the scalp is in the form of furuncles and carbuncles. These are usually situated in the thick cellular tissue at the back of the neck. The diagnosis can be readily

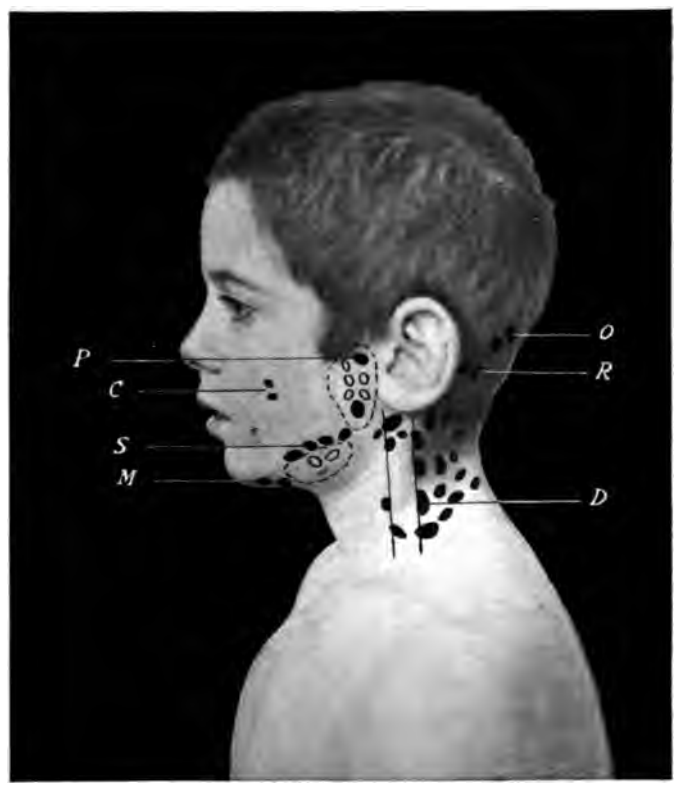

FIG. 30.—LYMPH-NODES OF FACE AND NECK.

The deep nodes are shown as black solid areas; the superficial as a black circle: *P*, Lymph-nodes lying within capsule of parotid gland; those lying upon the parotid and beneath the skin (preauricular nodes) are shown as black circles; *C*, lymph-nodes occasionally present in substance of cheek; *S*, submaxillary nodes lying within capsule of gland—those lying between the capsule and skin are shown as black circles; *M*, submental nodes; *O*, occipital nodes; *R*, postauricular or mastoid nodes; *D*, deep cervical nodes lying along the anterior and posterior borders of the sternocleidomastoid muscle and internal jugular vein, communicating with the nodes of the posterior triangle.

made from the central suppurating point in a furuncle and the tense area of infiltration surrounding it, which is quite characteristic of cutaneous infection in this region. In a carbuncle, the area of induration is much more extensive and there are multiple foci of sup[illegible]

Carbuncles may become so large that practically the entire space below the occipital protuberance, as far down as the vertebra prominens, is occupied by a suppurating focus.

Infection of the Lymph-nodes.—The lymph-nodes draining the scalp are situated in front of and behind the ear, the former lying directly upon the parotid gland, the latter lying just below the superior curved line of the occipital bone. These nodes may become enlarged and suppurate, the suppuration often being very resistant to treatment. The diagnosis can be readily made, by feeling nodules beneath the skin situated at the characteristic locations (Fig. 28), and every effort should be made to ascertain where the primary source is. Pediculi capitis, eczema and furuncles of the scalp can cause such an enlargement and suppuration of the lymph-nodes draining the scalp.

Phlegmon of the Scalp.—This usually follows infected scalp wounds. It can be recognized by the angry, swollen appearance and the tenderness of the edges of the scalp wound accompanied by fever, rapid pulse and other signs of infection. The granulations become edematous and there is constant discharge of pus. Pus may accumulate beneath the subaponeurotic layer, so that the entire scalp is raised, giving rise to distinct fluctuation all over the skull. The limits of the boggy swelling are the superior curved line of the occipital bone behind, the supraorbital ridge in front, and the zygomatic processes at the sides.

There is always danger in these cases of a septic thrombosis or meningitis, and the symptoms (see page 61) of these conditions should be looked for, especially if the phlegmon complicates a compound skull fracture.

Erysipelas of the scalp usually exists as a complication of the same disease in the face. It differs from ordinary infection of the skin of the scalp by causing a tense infiltration with edges sharply marked. The diagnosis can be made from this tense infiltration as well as from the many small bullæ or blisters and the pinkish discoloration of the skin of the scalp, which, like the infiltration, terminates rather sharply. Such a sharp demarcation is characteristic of erysipelas elsewhere, and is described more fully in the diagnosis of facial erysipelas on page 102. There is usually also some rise of temperature and moderate constitutional disturbance.

Subpericranial abscess is a collection of pus between the pericranium and the skull. It is usually secondary to pyogenic or tuberculous osteomyelitis of the cranial bones or to suppuration of a cephalhematoma. The diagnosis can be made from the presence of a deep-seated swelling over the skull, which gives evidences of fluctuation.

Tumors of the Scalp.

Tumors of the scalp may be either benign or malignant. The benign are far more frequent. In adult life, **sebaceous cysts** constitute the larger number of benign tumors of the scalp. They occur either singly or as multiple tumors and can be recognized from the fact that the tumor projects above the level of the scalp, the skin over it being stretched. It is distinctly movable upon the aponeurosis, and as a rule the skin covering it is not adherent. It is round in form but in the occipital region may be polypoid. If the base is ulcerated and hard, carcinomatous degeneration should be suspected (see Fig. 31).

Dermoid cysts are usually smaller than sebaceous cysts and are situated at definite places, such as the root of the nose, inner and outer

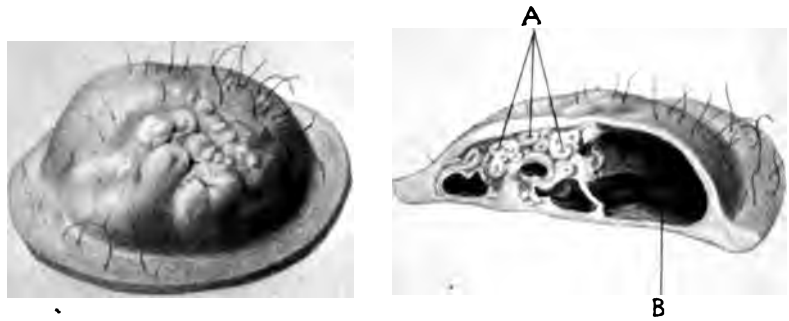

Fig. 31.—Carcinoma Developing in Sebaceous Cysts of Scalp.
A, Formation of new cysts as a part of the malignant process; B, cavity of original cyst.

angles of the orbit, and at times within the orbit itself. Their size varies from a hazelnut to an egg. Their base is usually fixed, so they can be moved but little upon the skull, being firmly attached to it.

A dermoid cyst must be differentiated from a meningocele. The latter occurs in the median line at the front and at the back of the skull (Fig. 33). The meningocele can usually be compressed, pulsates, and enlarges when any exertion is made. In children, in whom meningoceles are most frequently found, crying causes them to become more tense, and the reduction of the contents causes cerebral pressure symptoms. After a meningocele has been reduced, one may feel the edges of the gap in the skull through which the tumor has protruded (see page 19).

Among the rarer forms of tumor of the scalp may be mentioned a **pneumatocele,** which will be readily recognized by the fact that it is

situated over the mastoid or frontal regions, usually the former. It contains air, so that it is tympanitic on percussion. It is soft and elastic, and the air can be gradually pushed in through the gap in the skull.

Lipoma of the scalp occurs, chiefly in the frontal and temporal regions, as a flat, soft tumor, which does not raise the scalp as much as either dermoids or sebaceous cysts. In the temporal region it may attain some size, and give rise to a sense of pseudo-fluctuation.

Fibromata are rare. They are usually quite soft, and often present as a part of a generalized condition.

FIG. 32.—SEBACEOUS CYST OF OCCIPITAL REGION WITH ULCERATION OF SURFACE.

Warts can be readily recognized on the scalp. They are quite small, and bleed easily.

Pigmented moles occur quite frequently and are recognized by their brownish color, and the fact that they are slightly raised above the level of the skin of the surrounding scalp. They may develop into melanotic sarcomata (see below).

Vascular tumors of the scalp are most often present in the form of *simple angiomata* upon the forehead. They appear as bright red spots, slightly raised above the level of the scalp. The color can be caused to disappear by pressure, but immediately returns when the finger is taken off. The distribution of simple or capillary angiomata quite often corresponds accurately to the area of distribution of the three branches of the fifth cranial nerve. Attention was first called to this fact by Bärensprung, and his observations confirmed by Cushing and others.

A second type of angioma is the *cavernous*, which may occur with the simple or capillary form or be present independently. If the latter is the case the scalp is only slightly discolored, of a purplish hue, and the soft tumor can be caused to disappear to a great extent by pressure.

The fact that they do not pulsate and that there is no gap in the skull after they have been decreased in size by pressure, readily distinguishes simple and cavernous angiomata from meningoceles. At times

they increase somewhat in size when the child cries, which may lead one to suspect the presence of a meningocele.

A third variety of vascular tumor is the *cirsoid aneurysm*, which can be recognized as a mass of tortuous, elongated, and dilated arteries. It feels like a bunch of worms and occurs especially in the frontal and temporal regions. It can be emptied by pressure, but refills. It pulsates, but ceases to do so when the temporal artery is compressed. This pulsation must be differentiated from that of a pulsating soft sarcoma, by the peculiar feeling one gets of elastic tubes filled with blood.

A fourth rare variety of vascular tumor is the *traumatic aneurysm*, in which there is a pulsating tumor, usually in the temporal or frontal regions, with an expansile pulsation and a distinct bruit.

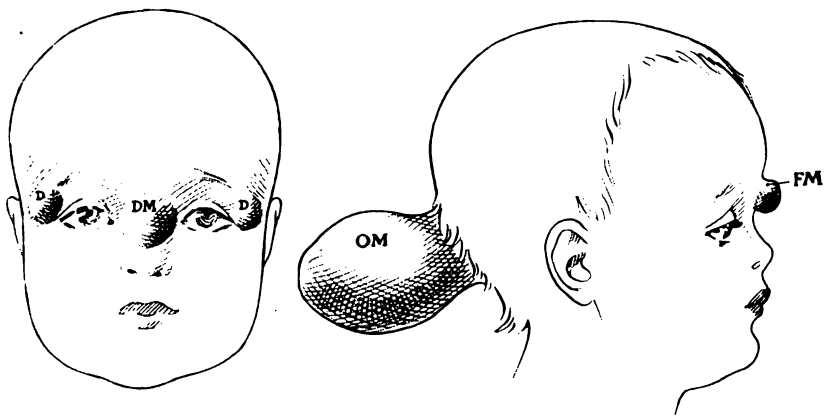

FIG. 33.—LOCATION OF VARIOUS TUMORS OF SKULL AND FACE (DIAGRAMMATIC).

D, Location of dermoid cyst at outer angles of orbits; *DM*, location of dermoid cysts at root of nose, and of meningocele of the naso-frontal type; *FM*, naso-frontal form of meningocele; *OM*, occipital form of meningocele.

A fifth variety is the *arterio-venous aneurysm*, which occurs either in the temporal or posterior auricular arteries. It can be recognized by the marked dilatation of the superficial veins leading to it, and the peculiar whirring bruit and expansile pulsation at the point of communication of the vein and artery.

Malignant Tumors of the Scalp.—*Sarcomata* occur either as melanotic sarcomata or as bleeding warts, in elderly people. They are usually soft, with overhanging edges, and can be recognized as belonging to the class of malignant tumors by their steady growth in all directions.

Carcinoma occurs as a primary form, either arising from sebaceous cysts (Fig. 31), or as a rodent ulcer on the forehead. The former can be recognized by the ulceration or induration of the base of a sebaceous cyst.

DISEASES OF THE SKULL.

Diseases of the cranial bones are divided as follows: (A) Atrophic processes. (1) Senile atrophy. Begins in diploë and produces depressions over parietal bones. (2) Hemifacial atrophy—a unilateral lack of development due to trophic disturbances of the fifth nerve. (3) Rachitic atrophy (craniotabes) which causes the skull to become greatly thinned over the parietal and occipital bones. It is often associated with hydrocephalus (see page 81). It can be recognized by the peculiar elastic thin places over the occipital bone. (*B*) Hypertrophic processes. (1) General overgrowth, *i. e.*, gigantism. (2) Acromegaly due to disease or tumor of the hypophysis cerebri and causing enlargement of the skull and face bones as well as those of the hands and feet. (3) Leontiasis ossea,[1] which affects either the cranial or facial bones or both. There is marked hyperostosis, both in an inward and outward direction, causing pressure on the nerve-trunks passing through the bones, and in 45 per cent. of the cases upon the cerebrum. (4) Osteitis deformans (see page 679). This affects the skull as a part of a general process which causes bowing of the long bones and spine accompanied by eccentric hypertrophy of the cranial vault. The disease may affect the skull alone.

FIG. 34.—TERTIARY SYPHILITIC NECROSIS OF THE FRONTAL BONES.

Note the sharp, clean-cut edges of the area, and the necrotic bone in the center of the ulceration.

INFLAMMATORY PROCESSES.

1. **Tuberculosis of the skull** may occur at any age, but is especially frequent in infancy and childhood, in the mastoid and petrous portions of the temporal bone. It occurs less frequently in the frontal and parietal bones. It can be recognized by its slow, insidious character. Unless there are intracranial complications, it causes but little tenderness or

[1] Kanavel, "Surgery, Gynecology and Obstetrics, vol. iv.

pain. Cases may present themselves with one of two conditions present, (*a*) either a sinus, lined with typical yellowish tubercular granulations, leading to bare and soft bone, or (*b*) as an unopened, cold abscess. Under the latter conditions care should be taken to differentiate such an abscess in the temporal region from a lipoma (see page 74).

The disease is a very progressive one, causing steady rarefaction of the bone, and often forming extradural collections of pus. These can be recognized by the presence of a dull headache and tenderness, and, in case of a large collection of pus, by the general symptoms of intracranial pressure.

2. **Syphilis of the Skull.**—This occurs in one of two forms, which can be readily diagnosed by a careful history, a search for evidences of syphilis elsewhere, and the characteristic local findings:

First, as a periostitis, in the early weeks of the secondary stage. Here it produces a soft, flat elevation of the periosteum, which is extremely sensitive and causes much pain, the latter being especially severe at night.

Second, in the form of open gummata resulting in a worm-eaten condition of the

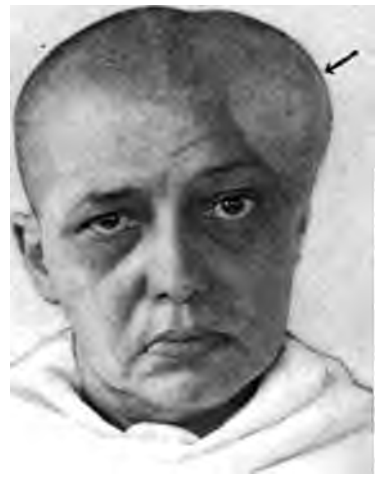

FIG. 35.—ANTERIOR VIEW OF CASE OF ANGIOOSTEOMA OF THE LEFT FRONTAL AND PARIETAL BONES.

FIG. 36.—POSTERIOR VIEW OF ANGIOOSTEOMA OF PARIETAL BONE.
Same case as shown in Fig. 35.

bone (Fig. 34). Large areas of both tables, but especially the outer, become necrotic, and form sequestræ by a process of progressive osteoporosis or rarefaction. Each area is surrounded by a zone of osteosclerosis or hardened bone. Perforation of the skull, with subdural collections of pus, causing pressure symptoms, as is the case in tuberculosis, is quite rare in syphilis.

Acute pyogenic osteomyelitis and periostitis is rare except after compound fractures. Usually there is considerable pain around the scalp wound. The scalp itself is red and swollen, there is distinct fluctuation, and when the wound in the skull is examined one either finds sequestræ, or the diploë is infiltrated with pus.

FIG. 37.—MULTIPLE OSTEO SARCOMATA OF THE SKULL.

The white arrows point to tumors situated in the right parietal and left frontal bones respectively. The protrusion of the left eye is caused by a tumor which has formed in the left frontal sinus, pushing the eye downward and outward.

The chief point of interest in the diagnosis is to be able to exclude the various intracranial complications referred to on page 63.

TUMORS OF THE SKULL.

Osteomata.—This form of tumor may occur either on the vertex of the skull or in one of the accessory sinuses, such as the frontal and sphenoidal. On the vault of the skull they may be diagnosed from the fact that their growth is very slow, their borders are sharp, they are extremely hard, are conical or mushroom in shape, and occur usually in the parietal and frontal bones. The osteomata may contain large vascular spaces and show a feeble pulsation. To this variety the name of angioosteoma has been given (Figs. 35 and 36).

Osteomata of the frontal sinus cause a diffuse swelling in the inner angle of the orbit, if they are unilateral, or at the middle of the forehead, if bilateral. They displace the eyeball, and can only be recognized when they have grown beyond the walls of the frontal sinus, unless a skiagraph is made. In the latter the shadow due to such a bony tumor can be readily distinguished from the translucent area which normally represents the frontal sinus.

Osteomata of the sphenoidal sinus can be recognized from the pressure symptoms which they cause on the eyeball and optic nerve. If osteomata grow toward the inner side of the skull, their presence can be only suspected from the focal symptoms.

Echinococcus of the skull is quite rare and usually appears in the bone itself, but as often between the dura and the bone. It appears upon the surface as a cystic tumor, which can be recognized as an echinococcus if the disease is found elsewhere, or the characteristic hooklets are found in the cystic fluid.

Sarcoma.—Sarcoma of the skull may occur as a primary or secondary tumor in the periosteum or in the bone itself. In both of these tumors appear which are hemispherical, and grow rapidly, are hard at first, and later become soft and ulcerated.

FIG. 38.—ENCEPHALOCELE IN BOY AGED THIRTEEN YEARS. TUMOR PRESENT SINCE BIRTH SOFT, PULSATING WHEN SLIGHT PRESSURE IS EXERTED. (Dr. Mortimer Frank.)

Secondary sarcomata are more often multiple than the primary. They can be recognized by the fact that they have all of the characteristics of the primary growth just referred to, and the history or presence of such a primary focus.

Primary tumors of the dura, tumors of the brain or of the frontal, ethmoidal, or sphenoidal sinuses may penetrate the skull and grow externally as well as into the cranial cavity itself (Figs. 39 and 40). They cannot be distinguished from primary skull tumors, unless the case has been under observation from the earliest period. These dural sarcomata usually pulsate and cause intracranial symptoms.

Primary sarcomata of the brain may grow through the skull and present externally. Their growth is usually more diffuse than primary tumors of the dura.

Carcinoma of the skull is never primary. It is either secondary to a carcinoma elsewhere in the body, especially of the breast, thyroid or prostate, or the cranial bones are secondarily involved from a carcinoma of the scalp. Other forms of neoplasm which can occur in the skull are myeloma and chloroma.

Congenital Defects of the Skull.

These are quite rare. Trelat found only five cases in 13,000 births. They usually occur in the frontal region, at the root of the nose or in the occipital region, either above or below the external occipital protuberance. Quite rarely one finds a congenital defect at the base of the skull or into the orbit. In the former the tumor projects into the pharynx; in the latter it appears at the inner or outer angle of the orbit (Fig. 38). The tumor which projects from the congenital defect

Fig. 39.—Side View of Sarcoma of Frontal Bone Which Invaded Interior of Skull and Orbit, Causing Displacement Outward of the Eye.

Fig. 40.—Anterior View of Tumor (Sarcoma) Originating in Frontal Bone, Which Invaded Cranium and Orbit and Caused Displacement of Eye. Same Case Shown in Fig. 39.

may be either composed of dura and cerebrospinal fluid alone (meningocele), or it is made up of dura and cerebral tissue (encephalocele, or, finally, one of the lateral ventricles may be a part of the tumor, the overlying brain tissue being greatly atrophied. The frontal tumor is usually an encephalocele. It is small, flat, nonpedunculated, and the skin over it is thick and very vascular. The occipital variety is usually larger, has a narrow pedicle, is regular in outline and round (Fig. 31). The most characteristic symptoms of all these tumors are their typical locations, combined with the fact that the smaller ones are reducible. Such a re-

duction is often accompanied by signs of cerebral compression, such as convulsions, etc. The smaller ones (meningoceles) are often translucent and increase in size or become tenser when the child cries. Occasionally the defect in the skull can be palpated. The smaller ones may persist for years without symptoms; the larger ones cause death through a meningoencephalitis.

NON-TRAUMATIC SURGICAL AFFECTIONS OF THE BRAIN AND ITS ENVELOPES.

HYDROCEPHALUS.

Hydrocephalus is only a symptom and not a disease. The chief form of hydrocephalus which is of surgical interest is the chronic internal form. It may be congenital or acquired. At times it may be impossible to differentiate in a given case whether the condition was a congenital one or not. The causes for both are the same, before the sutures and fontanelles are closed. These causes are a cerebellar tumor obstructing the outflow of cerebrospinal fluid from the ventricles or a primary ependymitis or a posterior basic meningitis, or it may follow the closure of a spina bifida.

The diagnosis of hydrocephalus should never be made without comparing the circumference of the head with that of a normal child at the same age.

A true congenital hydrocephalus must be differentiated from the hydrocephalic condition which occurs in rickets. They can, however, be distinguished from each other by the fact that in true hydrocephalus there is apt to occur spastic rigidity, accompanied by convulsions and paralysis, as well as contractures in the paralyzed parts (Fig. 41).

There is great impairment of mental development in hydrocephalus. The head is often retracted, there are night cries, unsteady gait and emaciation. In rickets the head is square or box-shaped; the fontanelles, although they are open, do not bulge; there is usually accompanying craniotabes but the enlargement is not so marked as in hydrocephalus. There are also usually present the characteristic rachitic enlargements at the junction of the costal cartilages and ribs and at the ends of the long bones, especially at the lower end of the radius and ulna.

Congenital hydrocephalus must be differentiated from the chronic form due to tumors arising in early life from the third ventricle and in the posterior fossa of the skull. In these the enlargement of the head is very gradual and has not been present from birth, as in congenital hydro-

cephalus. In addition there are usually other general and focal symptoms, including, in the case of tumors, the presence of choked disc and other signs of cerebellar tumors (see page 84).

FIG. 41.—SIDE VIEW OF CHILD SUFFERING FROM HYDROCEPHALUS.

Note how the face seems to be a mere parasite upon the enormous enlargement of the skull.

TUMORS OF THE BRAIN.[1]

The diagnosis of tumors of the brain can be made by the careful study of certain general and focal symptoms. The general symptoms indicate an increase of intracranial pressure. The focal symptoms are the evidences of pressure upon localized areas of the brain, causing more or less interference with their special functions. The **general symptoms** in the order of their frequency are:

I. *Headache.*—The headache is of a deep boring character, usually quite severe. It is rarely localized over the seat of the tumor, but is usually diffuse all over the head. In tumors of the posterior fossa (pons, medulla, and cerebellum), the pain is characteristically situated in the occipital region.

II. *Nausea and Vomiting.*—The character of cerebral vomiting is that it occurs without any effort, the contents of the stomach being thrown at times some distance in a projectile manner. The vomiting

FIG. 42.—SECONDARY CONTRACTIONS OF THE WRIST- AND FINGER-JOINTS IN HYDROCEPHALUS.

[1] Duret's statistics of 344 cases of brain tumors as to location show that 63.5 per cent. were in the motor area, 12.8 per cent. were in the frontal lobe, 10 per cent. were parietal and occipital, and 13.7 per cent. were cerebellar.

is also seldom preceded by nausea and is independent of the taking of food.

Papillitis.—This is present at some stage in the majority of cases in one or both eyes and is one of the most reliable signs. It is usually of such a degree as to give rise to the name *choked disc.* The larger the tumor, the more marked is this symptom. In cerebellar tumors it appears quite early, while in those in the motor region it appears quite late and in only 40 per cent. of the cases. It almost always results in optic atrophy. When it is unilateral, the tumor is almost always on that side.

IV. *Mental Symptoms.*—Stupor marks the onset of the symptoms. It gradually develops into coma, which varies greatly in its intensity. Remission of the coma aids in distinguishing tumor from abscess of the brain, because the stupor and coma in the case of a tumor increase and decrease from time to time as the intracranial pressure rises or falls. The psychical symptoms vary greatly and are most marked in tumors of the frontal lobe. There may be simple mental failure (loss of memory) and dullness, or marked mental confusion, or even actual delirium. Witzelsucht or loquaciousness, with a tendency to joke on all subjects, is occasionally found in tumors of the first frontal convolution.

V. *Slow Pulse and Marked Increase of Blood-pressure.*—In many cases of brain tumor both of these symptoms are quite marked, the pulse sinking at times to forty beats per minute and the blood-pressure rising greatly, as determined by the use of the modified Riva-Rocci apparatus.

VI. *Vertigo.*—This is especially marked in cerebellar tumors, and is of value as a symptom if other causes of vertigo, such as labyrinthine disease of the ear and of the stomach, can be eliminated.

VII. *Apoplectiform attacks* occur from time to time through hemorrhages into gliomata, and may simulate ordinary apoplexy in the absence of a complete history.

VIII. *General convulsions* are apt to occur if the tumors are in the cerebral cortex.

IX. The skull is tender over the site of the tumor if the latter is superficial.

Focal Symptoms.—*Tumors of the Frontal Lobe.*—There are no localizing symptoms unless the growth compresses the motor centers in the precentral gyrus, or the motor speech-center in the third left frontal convolution. Marked disturbances in mentality are usually associated with general symptoms of cerebral pressure in tumors of the frontal lobe, and are more marked in those of the right side. These mental disturbances are mental dullness or confusion, witzelsucht, irritability and child-[redacted] or loss of memory.

Motor Region.—Attacks of Jacksonian epilepsy occur in tumors of the precentral gyrus. The parts which twitch, or are affected by disturbances of sensation and motion, vary according to the area involved (Fig. 23), so that it is possible to more accurately localize tumors of this region than those of almost any other. As the tumor grows, the attacks extend over a greater number of muscles, but are always localized, according to the situation of the motor centers in the cortex. For example, it may begin in the muscles of the leg and then involve those of the arm, and later still those of the face, on the side of the body opposite to that upon which the tumor is situated in the brain. Later in the course of the disease pareses or paralyses or even contractures occur in the affected muscles. There is usually an increase of the deep reflexes. Other symptoms than those of cortical irritation or pressure upon the motor centers are not infrequently associated in tumors of the postcentral gyrus, some through direct pressure upon adjacent areas in the parietal or frontal lobes, others due to indirect effects of pressure (Fernwirkung). In tumors of the postcentral gyrus (Fig. 23) there are convulsions of the Jacksonian type, preceded by a sensory aura. Later on there are disturbances of the sense of pain and temperature, rarely of touch. If the tumor is on the right side in left-handed people, there may be motor aphasia or agraphia; if the third frontal convolution is compressed there is a loss of muscle sense and anesthesia of the paralyzed limb through pressure upon the parietal lobe.

Tumors of the Parietal Lobe.—Tumors of this lobe can be recognized by the presence of attacks of Jacksonian epilepsy preceded by sensory symptoms, and later by the presence of a marked loss of muscle sense or astereocognosy. If situated in the lower part of the parietal lobe, they may produce word-blindness and often agraphia.

Tumors of the left temporo-sphenoidal lobe produce word-deafness, paraphasia and auditory hallucinations. This is the case especially in tumors of the first left temporo-sphenoidal gyrus. In tumors of the posterior portion of the left temporo-sphenoidal lobe, and extending toward the occipital lobe, there is visual aphasia.

Tumors of the Occipital Lobe.—Tumors involving the cuneus and first occipital convolution produce disturbance of the sense of smell and homonymous hemianopsia. Involvement of other portions of the lobe, if the cuneus is not greatly involved, produces soul-blindness, or incapacity to understand the things which one sees.

Tumors of the Cerebellum.—Tumors of the cerebellum, in addition to producing the well-marked symptoms of increased intracranial pressure, referred to under the head of general symptoms, produce

somewhat characteristic focal symptoms. Vomiting is quite frequent. Early optic neuritis with blindness occurs very early, and paralysis of the external rectus muscle is very common and often bilateral. There is also apt to be rigidity of the neck, and involvement of the olfactory, oculomotor, and trigeminal nerves on the side of the tumor. One of the most characteristic symptoms is a severe occipital headache, most marked upon arising. Attacks of amyasthenia and general vertigo are also frequent. Another characteristic symptom is the so-called cerebellar ataxia. This latter is especially marked in children, who have a tendency to fall to one side in walking; usually toward that upon which the tumor is situated.

Tumors of the Pontomedullocerebellar Space.—A class of tumors has been recently described whose essential features distinguish them from tumors of the cerebrum and cerebellum. This feature is the early appearance of symptoms referable to the fifth or eighth cranial nerves. When involving the eighth nerve they are sometimes described under the name of neurofibromata of the acoustic nerve. They grow slowly, hence the symptoms referable to the involvement of the fifth or eighth nerve may precede the other symptoms for a long period. In the case of the fifth nerve these prodromal symptoms are obstinate and show themselves as atypical attacks of facial neuralgia, for which no other peripheral or central cause can be found. The symptoms of the early involvement of the eighth nerve are tinnitus aurium with progressive diminution of hearing and aural vertigo. As the tumor increases in size, we have other evidences of pressure.

The diagnosis rests upon the symptom-complex of tumors of the posterior fossa, preceded by well-marked and long-continued signs of auditory or trigeminal involvement. These general and focal symptoms are those of increased intracranial pressure in the posterior fossa and are—(1) general: headache, vertigo, vomiting, optic neuritis, bradycardia; (2) focal: peduncular ataxia, cerebellar ataxia, lateropulsion, hemiasynergy, homocontralateral and crossed paralyses of the extremities, paralysis of the cranial nerves at the base of the skull (especially the fifth, sixth, and seventh), dysarthria, dysphagia, nystagmus, paralysis of the conjoint movements of the eyes, inequality of the pupils, and attacks of Adams-Stokes syndrome.

Before making a diagnosis of a primary tumor of these nerves, one must exclude primary disease of the base of the skull and meninges, such as syphilis and tumors of the bones of the base of the skull, and also exclude aneurysm of the vertebral artery.

Tumors of the Middle Fossa of the Skull.—These have their origin either in the pituitary body or the optic chiasm. If the pituitary

body is involved the symptoms may for a long period be those of acromegaly (Fig. 44) and the general symptoms of intracranial pressure may not appear for a long period.

In tumors involving the optic chiasm irregular forms of hemianopsia appear. Optic neuritis and atrophy are very early symptoms.

The diagnosis of whether a tumor of the brain exists, and where it is located, may be made from a consideration of the general and focal symptoms just referred to. Of the former, the most constant are the headache, the vomiting, the choked disc, slow pulse, and mental symptoms, including stupor or coma, as the case may be. Headache, vomiting and optic neuritis are the three most important symptoms of this group. The focal symptoms will depend upon the location of the tumor and the extent to which neighboring areas of the cerebrum or cerebellum are pressed upon. The clinical evolution of a brain tumor varies greatly.[1] There may be complete latency of all of the symptoms and the tumor remain unsuspected during life. In other cases one of the symptoms pointing to cerebral tumor, such as headache or vertigo, may be present, but a considerable time, even years, may elapse before other symptoms occur which warrant a definite diagnosis. The general symptoms may be first manifested, localizing symptoms occurring later or not at all, and the opposite may be the case. When localizing symptoms occur, they are of less value than if they occur early. No brain tumor, except gumma or tubercle, when once developed, ever disappears. No tumor may be found at operation, and yet great intracranial tension exist. Radiography of the skull has thus far been very unsatisfactory as a means of diagnosis in tumors of the skull.

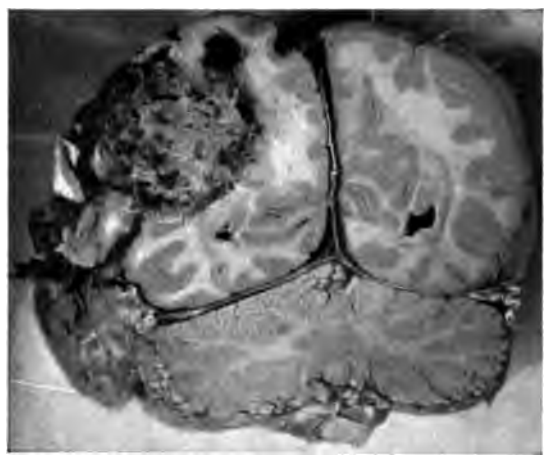

FIG. 43.—GLIOMA OF LEFT PARIETAL LOBE, WITH MULTIPLE HEMORRHAGES. (Harvey Cushing.)

General symptoms relieved by decompression for many months. Local symptoms were hemianesthesia, hemianopsia and visual word-blindness.

[1] The following lines, to "nature of the tumor," are taken from the excellent treatise on brain surgery by Ballance.

In regard to the *nature of the tumor*, variations in pressure—that is, remission in the symptoms and apoplectic attacks—speak for gliomata. These occur especially in childhood and early life. Syphilitic gummata can only be distinguished from other tumors of the brain by the history of preceding infection, or finding evidences of syphilis elsewhere in the body. They are apt to occur late in life.

Multiplicity of symptoms speaks for tubercles. These occur especially in childhood, and there is often evidence of a tuberculous focus elsewhere.

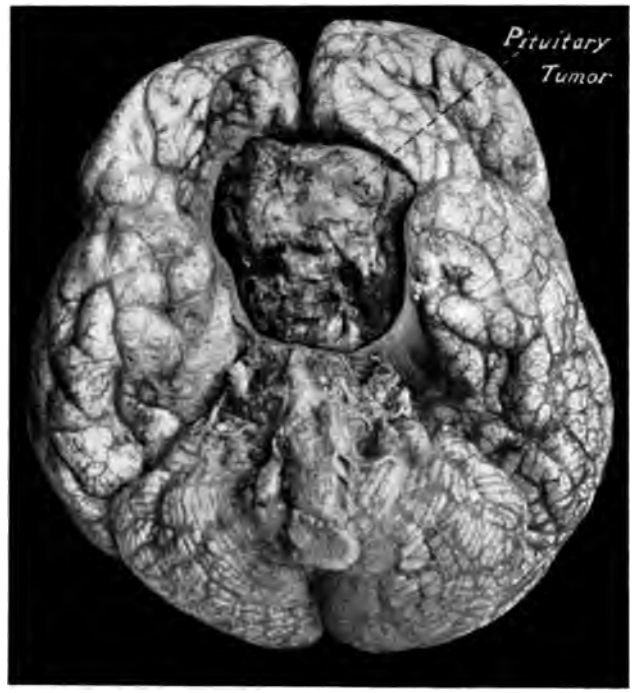

FIG. 44.—TUMOR OF PITUITARY BODY CAUSING ACROMEGALY.

The following is a list of the most frequent cerebral tumors which are of surgical importance: (1) *Endothelioma.* These are the most frequent of the true neoplasms. They grow from the meninges, are encapsulated and loosely attached. (2) *Syphiloma.* This is a gumma, but of so dense and fibrous a consistency as to resist the action of potassium iodid in many cases. They may be quite large and are often multiple. (3) ***Tuberculoma.*** This is an encapsulated tuberculous focus with a thick capsule. It is rarely primary, varies greatly in size, and usually occurs in the pons or cerebellum of children. (4) *Glioma.* This form of tumor arises from the neuroglia tissue. It is soft, infiltrating and very vascular. Hemorrhages into the tumor mass causing apoplectiform

attacks are quite common. Cyst formation is also a frequent accompaniment of a glioma. (5) *Carcinoma.* Is quite common as a secondary growth in the brain, the primary being elsewhere in the body. (6) *Sarcoma.* Secondary growths like those of carcinoma are the most frequent form of sarcoma of the brain. (7) *Cysts.* These may be simple, hemorrhagic, parasitic or due to extradural or intradural dermoids. The most frequent forms are those which are the result of a glioma or follow a traumatic or other hemorrhage. The rarer forms of tumors are the psammoma, osteoma, fibroma, angioma and myxoma. A few cases have been reported where the tumor followed a trauma, but there is no such relation in the majority of cases.

The general conclusion in regard to the diagnosis of brain tumors is that no one symptom is pathognomonic. Neither headache, vomiting, optic neuritis, convulsions, vertigo nor hemianopsia alone warrant the diagnosis of brain tumor, but two or more of these in combination do constitute evidence of the existence of a brain tumor (Ballance).

In the *differential diagnosis* of tumor of the brain one must exclude abscess of the brain, gummatous meningitis and primary ependymitis with ventricular hydrops. Multiple sclerosis may also simulate a tumor, especially if there is optic neuritis or atrophy present, but there are usually no stupor, convulsions, slow pulse, vomiting, aphasia, or cortical epilepsy present in this disease.

The eye should be examined in every case of long-continued headache, and, if choked disc be found, the following other causes for it should be excluded: Hydrocephalus, gummatous meningitis, abscess of the brain, nephritis, chlorosis, and chronic lead-intoxication.

The differential diagnosis of abscess from tumor of the brain is given in the following table:

Tumor.	Abscess. (See below.)
1. No primary focus of infection but often history of syphilis or malignant disease of other organs.	1. Suppurating area in ear, nose, pharynx, scalp, or lung abscess, or history of trauma.
2. Very slow development.	2. More rapid, as a rule.
3. More definite focal symptoms.	3. Focal symptoms often present but not so definitely localized as in tumor.
4. No rigors or septic symptoms.	4. Often begins with chills, septic symptoms often continue.
5. Temperature normal or slightly and irregularly elevated.	5. Temperature subnormal, other times higher—pus temperature.
6. Pulse slow.	6. Not slow as a rule.
7. Constant headache.	7. Not a constant or prominent symptom.
8. Projectile vomiting frequently present.	8. Not often; vomiting, if present, more frequent and not projectile.
9. General symptoms of pressure progressive.	9. When present, they vary greatly in intensity.
10. Choked disc constant.	10. Not constant.

Abscess of the Brain.

This condition was discussed in its relation to injuries of the head, on page 64, and as a complication of middle-ear disease on page 91. After injuries the abscesses are usually in the cortex—especially the acute form. After influenza, gangrene of the lung, and rarely during pyemia, abscess of the lung may also occur. Finally, nearly 50 per cent. of all brain abscesses are of otitic origin. A second abscess is rare in the temporo-sphenoidal lobe, but is more common in the cerebellum. In otitic cerebral abscesses a focus of suppuration may exist simultaneously in the temporo-sphenoidal lobe and cerebellum. There are five types of clinical evolution of a cerebral abscess, according to Bissaud, quoted by Ballance.[1] First type—subacute evolution. In this there are three stages: (*a*) An initial febrile; (*b*) a stage of calm; (*c*) the paralytic stage. Apoplectiform attacks with a coma or there is recovery with focal signs. Second type—evolution with severe general infection. Third type—complete latency until final attack of coma. Such abscesses are usually in the silent area, *i. e.*, the frontal lobe or the postero-external portion of the occipital lobe or in the right temporo-sphenoidal lobe. Fourth type—evolution like brain tumor. Symptoms almost the same, except that choked disc is more constant in brain tumors. Fifth type—remittent type. First there is headache, fever, mania, or delirium. Then the process quiets down and is rapidly fatal.

THE INTRACRANIAL COMPLICATIONS OF MIDDLE-EAR AND MASTOID SUPPURATION.

These are:

1. Epidural abscess or otitic pachymeningitis.
2. Purulent leptomeningitis.
3. Serous meningitis.
4. Cerebral and cerebellar abscess.
5. Sinus thrombosis.

I. Extradural Abscess.

(Epidural or Perisinuous Abscess.)

This condition is most frequently due to the extension of infection from a diseased mastoid or sigmoid sinus. It is more frequent on the right side. It is usually found during the operation for mastoid suppuration or may be suspected as a complication if symptoms such as fever, headache, tenderness, edema around the wound, and profuse discharge of pus persist, after opening the mastoid.

[1] "Some Points in the Surgery of the Brain," 1907.

Focal symptoms are rare except in children. If the extradural abscess is on the left side there may be sensory aphasia. If it is beneath the dura of the middle fossa there may be pareses of the opposite half of the body and disturbances of sensibility. There are also general symptoms of increased intracranial pressure such as somnolence, vomiting, slow pulse, pain, and choked disc.

All of these symptoms may be present in purulent meningitis and cerebral abscess, so that the diagnosis must be made to a great extent from the local findings, which are as follows:

1. Persistence of profuse purulent discharge from the ear after a mastoid operation.

2. Edema and tenderness around the wound and the formation of subperiosteal and subcutaneous abscesses and fistulæ just behind the mastoid or on the squamous portion of the temporal bone.

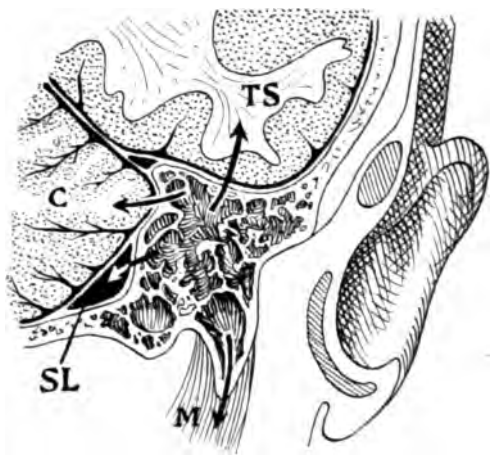

FIG. 45.—MODES OF TRANSMISSION OF INFECTION FROM MASTOID PROCESS.

The arrows show the direction in which infection travels: (1) into temporo-sphenoidal lobe, *TS*; (2) into cerebellum, *C*; (3) into lateral sinus, *SL*, and free apex of mastoid into tissues of the neck, *M*.

II. PURULENT LEPTOMENINGITIS.

This may appear in an acute or protracted form. As in other forms of intracranial complication of middle-ear suppuration, there are both general and focal brain symptoms in addition to those of the local infection.

The general signs of intracranial pressure are:

(*a*) Headache. This may be on the side of the disease alone. It may be frontal or occipital or be present over the entire head. It is usually quite severe.

(*b*) Optic neuritis. This may or not be present. It is less frequent in a leptomeningitis than in cerebral or epidural abscess. It is more often found in basilar than in cortical leptomeningitis.

(*c*) The pulse is rapid and there is often stupor and delirium.

(*d*) Respiration is slow, irregular at times, and may be Cheyne-Stokes in character.

The focal signs depend upon whether the meningitis is most marked at the base or on the convexity. If the process is pre-

dominant on the latter there may be focal signs such as one expects to find only in a cerebral or cerebellar abscess. These are paralyses upon the opposite side of the body, convulsions, motor aphasia or agraphia. If most marked at the base there is rigidity of the neck and paralyses of the cranial nerves (especially of the fourth and sixth nerves).

In the acute form the temperature is high, while in the protracted form it may be normal or subnormal.

It can only be differentiated from an extradural abscess by the results of the operative treatment, *i. e.*, if the condition of the patient improves after opening the skull, an extradural focus existed. If there is a continuation and progression of the symptoms, leptomeningitis is present.

Only by finding tubercles in the choroid coat of the eye or tubercle bacilli by lumbar puncture can one positively differentiate the protracted form from a tubercular meningitis. Convulsions are less common, however, in simple purulent meningitis than in tubercular.

From the epidemic form of cerebrospinal meningitis, one can differentiate it by the more marked neck rigidity and opisthotonos and by finding the meningococcus by lumbar puncture.

III. Meningitis Serosa (Serous Meningitis).

This may also occur in an acute or chronic form, and is in reality an edema of the meninges. The symptoms are similar to those of the purulent variety just described and one can only differentiate it by the absence of fever, by the absence of pus in the lumbar puncture, and the course of the disease, which tends to recovery in the majority of cases.

The symptoms of the chronic form are similar to those of tumor, both the general and focal symptoms. It is only by recalling the fact that the symptoms have appeared after a middle-ear disease and the tendency to spontaneous recovery that one can make a diagnosis.

IV. Otitic Abscess of the Brain.

Indefinite symptoms such as slight headache and mental depression and evening rise of temperature may exist for weeks to months in a patient suffering from a chronic otitis media and then suddenly marked cerebral symptoms appear. In other cases the symptoms may appear as a complication of one of the three following conditions:

(*a*) A chronic purulent discharge may suddenly cease.

(*b*) As an accompaniment of an acute otitis media and mastoiditis.

(*c*) Acute exacerbation of a chronic purulent discharge.

The majority of the abscesses are located in the temporo-sphenoidal lobe, the remainder in the cerebellum (Fig. 39).

The **general symptoms** of brain abscess are:

1. Headache which may be located over any portion of the head, so that it is of little value as a symptom in localizing the seat of the abscess.

2. Nausea and vomiting.

3. The patient is mentally dull and becomes stuporous. As the intracerebral compression advances, coma sets in.

4. Convulsions occur, which are either localized or general. They are most frequently found in children.

5. Optic neuritis is more frequently present in abscess of the brain than in any other form of intracranial suppuration. It is usually simultaneous in its appearance in both eyes, but may exist on the affected side some time before appearing in the other eye. It is not as constant a symptom as in the case of a cerebral tumor and may not appear until late in the disease.

6. Slow pulse. This if present is a valuable sign of an increased intracranial tension, but it is quite inconstant in its appearance.

7. Localized tenderness of the skull is often present over the seat of the abscess.

Focal Symptoms of Brain Abscess.—*Temporo-sphenoidal Abscesses. Irritation and Paralytic Symptoms.*—These are pareses of the face, arm, and leg, on the opposite side of the body, often accompanied by spasms or convulsive movements in the affected muscles. Usually the face is involved first, then the arm, and last of all the leg centers.

Cortical facial paralysis can be distinguished from the peripheral form by the fact that in the former the eye muscles (orbicularis palpebrarum and corrugator supercilii) supplied by the facial are not involved. Abscesses of this lobe may also cause hemianesthesia and homonymous hemianopsia through indirect pressure. The latter two symptoms are often absent. In addition there may be paralysis of the motor oculi nerve on the side of the abscess. In a similar manner there may be hemianesthesia or motor aphasia, also through indirect pressure.

Abscess of the Cerebellum.—An abscess situated here usually causes vomiting and vertigo quite early. There are all kinds of pressure symptoms on the medulla, such as crossed paralysis, bilateral paralysis, and marked slow respiration and pulse.

Diagnosis of Otitic Cerebral Abscesses in General.—The diagnosis of an otitic cerebral abscess is impossible during the latent stage,

as well as in the terminal stage when the symptoms of meningitis, such as vomiting, restlessness, clonic spasms, rapid pulse and respiration and high temperature appear. If during this terminal stage the abscess has ruptured into the ventricle, instead of through the meninges, the pupils become widely dilated, the respirations and temperature are very high, and convulsions and tetanic seizures are followed by coma and death. The only stage in which a diagnosis can be made is in the so-called manifest stage, and even in this it is often uncertain. It is especially difficult in children, because the localizing signs are less marked and it is difficult to differentiate a tubercle from an abscess. The diagnosis is easy if one finds an external fistula leading to the abscess or if one opens the mastoid and finds a fistula leading through diseased bone to the abscess. In the majority of cases, however, there is no external fistula and one must depend on the brain symptoms alone.

The differential diagnosis between an extradural and an intracerebral or cerebellar abscess is very difficult unless found at operation, because both may cause the same symptoms, especially in children. The diagnosis from tumor is the most difficult of all, especially in children with tubercular disease elsewhere. Here the multiplicity of symptoms through the presence of multiple tubercles speaks for tumor, whereas symptoms which are due to the most frequent location of cerebral abscess speak for the latter.

Optic neuritis is usually more marked in tumors than in abscesses, and present at an earlier stage. The symptoms both general and focal of a tumor are slower in making their appearance, and there are apt to be periods of temporary improvement. (See page 82.)

V. Sinus Thrombosis.

The majority of these occur as a complication of mastoiditis or after a mastoid operation has been performed. There are two classes of cases:

1. Those with marked symptoms of sinus thrombosis and pyemia.

2. Those which resemble a septicemia in type and have no local signs of sinus involvement.

The symptoms of the first clinical form are:

1. Temperature. The fever is of the remittent type, there being a difference of 4 to 5 degrees in the daily temperatures.

2. Chills and sweats accompany the rises in temperature but may be absent, especially in children.

3. The pulse varies according to the temperature, being 120 to 140, during the chills.

4. The pain in the head is usually very severe, much more so than in an ordinary case of mastoiditis, and is referred to the side of the head and to the occipital region.

5. The sensorium is clear unless there is a complicating abscess or meningitis.

6. Optic neuritis and choked disc are present only in cases of cavernous sinus thrombosis.

7. Nausea and vomiting are usually present to a greater or less degree.

8. The spleen is enlarged and there are evidences of metastases in the lungs, subcutaneous tissues, and joints. The embolic abscesses in the lungs can be recognized by pains, coarse râles at various places, and prune-juice expectoration. These signs at first are localized but later are present over both lungs and may result in empyema or in pyopneumothorax.

9. Symptoms of thrombosis of the individual sinuses. In the case of the *sigmoid sinus* these are:

(*a*) The internal jugular vein is occasionally felt as a firm tender cord. This may be simulated by inflamed glands.

(*b*) Signs of compression of the ninth, tenth, eleventh, and twelfth cranial nerves—such as dyspnea, dysphagia, hoarseness, and slow pulse.

(*c*) Edema of the mastoid region.

In the case of the *cavernous sinus* they are:

(*a*) Edema of the forehead and eye-lids, chemosis, hyperemia of the retina, and optic neuritis (the latter is fairly constant in this form of thrombosis).

(*b*) Paralysis of the third, fourth, and sixth nerves.

(*c*) Retrobulbar edema with exophthalmos.

(*d*) Neuralgia of the supraorbital nerve (deep-seated pain).

(*e*) Dilated supraorbital, angular, and frontal veins.

The above ocular symptoms may appear in one or both eyes.

10. Leukocytosis is always present.

The diagnosis of the pyemic form of sinus thrombosis may be made from the remittent type of fever, splenic tumor, metastases, and local signs of thrombosis of either the sigmoid or cavernous sinuses. If associated with meningitis or abscess the symptoms of thrombosis predominate.

The septicemic form is characterized by the high continuous fever, rapid weak pulse, septic diarrhea, icterus, and nephritis. This form can be distinguished from typhoid by the absence of the Widal reaction and the presence of leukocytosis as well as by the mastoid involvement.

INJURIES AND DISEASES OF THE FACE.

INJURIES OF THE SOFT PARTS OF THE FACE.

The principal points of diagnostic interest in regard to injuries of the soft parts—that is, the skin and subcutaneous tissue—of the face, is that contused wounds around the orbit show a relatively larger amount of swelling than similar wounds in other parts of the body, owing to the loose arrangement of the subcutaneous connective tissue.

In contusions of the skin of the nose there is but little swelling or discoloration. It not infrequently happens that blows upon the nose, especially over the root of the nose, are followed by a considerable discoloration and swelling of the skin of the eyelids, which may not appear until from twenty-four to forty-eight hours after the injury. Contused wounds around the orbit have sharp edges, as though inflicted with a cutting instrument.

Incised, lacerated, and gunshot wounds of the face present no difficulty in diagnosis, and resemble in almost every respect similar wounds elsewhere in the body. As is the case in the scalp, a large flap of skin may be detached and still be followed by primary union.

In wounds penetrating the duct of Steno, in any portion of its course, a salivary fistula is apt to follow, if the duct is cut. This occurs most frequently in that portion of the duct which passes through the buccinator muscle, that is, about opposite the second molar tooth.

A division of the facial muscles causes no ill effects, with the exception of the levator palpebræ muscle, whose injury may result in inability to raise the upper lid.

Injuries of the arteries and nerves of the face occur in connection with lacerated and incised wounds, and at times after gunshot wounds. Bleeding from the facial artery or its larger branches is usually quite profuse. The effect of injury to the facial nerve depends upon which branches are involved. If the nerve is severed before it enters the parotid gland, a paralysis of all of the muscles of expression results. The muscles of the eyelids, those of the upper lip, and finally those controlling the lower lip, are paralyzed if the nerve is severed while within the parotid capsule or immediately after leaving it.

There is great danger of infection of the antrum in punctured wounds of the face. In gunshot wounds, the structures injured vary according to the course of the bullet, the chief danger being a laceration of the internal maxillary artery, which will result in the rapid formation of a hematoma and the escape of blood into the mouth.

Burns and freezing affect especially the tip of the nose and the more

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Burns and freezing affect especially the tip of the nose and the more

exposed portions of the cheek, and may result in deeper loss of tissue, with resultant cicatrization and deformities. This is especially true of burns, which may cause marked ectropion.

INJURIES OF THE BONES OF THE FACE.

FRACTURES.

Fractures of the nasal (Fig. 46) **bones** occur usually at their points of attachment to the frontal and superior maxillary bones. They are often complicated by fractures of the vomer and perpendicular plate of the ethmoid, as well as by fractures of the cartilaginous septum of the nose, separation of the lateral cartilages.

The diagnosis may be made from the flattened appearance of the nose. By grasping the nasal bones between the index-fingers of both hands and moving the nose in a lateral direction to and fro, one can readily obtain abnormal mobility and in many cases crepitus.

FIG. 46.—WIDENING OF NOSE FOLLOWING COMPOUND FRACTURE OF THE NASAL BONES IN BOY OF TEN.

Nasal Septum.—The diagnosis of injury of the nasal septum may be made in some cases from the external appearance alone, the nose being deviated. This deviation of the nose may involve the tip or the entire nose. There is usually considerable interference with respiration and more or less epistaxis.

The diagnosis of the extent of the injury to the septum can only be made by an examination of the interior of the nose through the anterior nares. At times the septum alone is bent, so that there is no deformity externally. Severe fractures of the nasal bones are often complicated by fractures of the anterior fossa of the skull, so that the symptoms of the latter predominate, and it is not until all swelling of the eyelids and

around the root of the nose has disappeared, that the diagnosis of the fracture of the nasal bones is made.

In fractures of the nasal bones which extend into the frontal sinuses, there may be extensive emphysema of the upper portion of the face. At times a fracture of the nasal bones will be followed by epiphora, through involvement of the nasal ducts.

Fractures of the Malar Bone.—This bone is usually fractured at its junction with the superior maxilla, or with the zygomatic process of the temporal bone. A rotation takes place of the malar bone, so that at its junction with the zygomatic process a distinct depression is to be

FIG. 47.—FRACTURE OF MALAR BONE.

A frequent seat of fracture of the malar bone is along the lines shown, namely, at its junction with the superior maxilla and the zygomatic process of the temporal bone. The arrows show the direction in which the fragments composed of the entire malar bone are dislocated.

felt, whereas at its point of junction with the malar process of the superior maxilla there is a prominence at the outer third of the lower border of the orbit (Fig. 47).

This deformity may be reversed if the blow has been received over the eye instead of over the zygoma, so that there is a depression along the lower border of the orbit and an elevation along the zygoma.

In crushing injuries of the malar bones there is a simple flattening of the prominent portion of the cheek which is normally formed by the malar bone.

There is great danger in these fractures of the malar bone, of injuring

the orbit or the infraorbital nerve. A depression over the zygoma may cause some interference with the use of the muscles of mastication.

Fractures of the Superior Maxilla.—Fractures of this bone seldom occur alone, being usually associated with those of the other bones of the face. They may simply involve the alveolar process, which occurs after faulty extraction of teeth or blows upon the jaw. Fractures of the body of the bone are usually multiple or comminuted.

The diagnosis may be made by inspection and palpation of the bone. At times one may feel a fissure in the bone, or a depression, which crepitates on pressure. The cheek is sunken in. Examination through the mouth shows that there is a distinct gap between two of the teeth, and if the fracture is a comminuted or a multiple one, as is often the case, there is abnormal mobility and the teeth are not in line with each other.

FIG. 48.—HEMATOMA OF FACE OVER MALAR BONE RESEMBLING MALIGNANT GROWTH, ON ACCOUNT OF SLOW ABSORPTION OF BLOOD AND MARKED INDURATION.

In fractures involving the anterior wall of the antrum, or in those in which the fracture line extends up into the frontal sinus, there may be some emphysema of the upper portion of the face.

Gunshot fractures of the superior maxilla or injuries following the bursting of shells in war are not infrequent. A diagnosis may be readily made by a direct inspection of the wound.

Fractures of the Inferior Maxilla.—The majority of these occur close to the canine teeth, either on one or both sides of the jaw. They most frequently follow a direct force, such as a blow, or a fall upon the chin. Fractures of the body of the lower jaw are far more frequent than those of the ramus. The latter are comparatively rare.

The diagnosis of a fracture of the body is not difficult, and may be made by grasping the jaw in the manner shown in Fig. 49 on either side

of the fracture, with the thumb and index-finger of each hand. One can usually obtain a false point of motion and crepitus. In addition, fractures of the body reveal, upon examination of the mouth, an unequal position of the teeth on either side of the fracture line and a tear in the mucous membrane.

Fractures of the ramus can be best felt through the mouth, by inserting two fingers of one hand far back into the mouth toward the ramus and manipulating the jaw between the fingers of this hand and those of the other placed on the outer side of the ramus. In some cases there is considerable deformity, due to the fact that the masseter muscle pulls the lower fragment upward, so that the fracture line in the ramus can be distinctly felt through the cheek from the outside. Fractures of the ramus are usually accompanied by considerable difficulty in chewing.

In fractures of the body of the bone, involving the inferior dental canal, neuralgic pains or anesthesia are often present, or there is a reflex lockjaw as a result of stimulation of the inferior dental nerve.

Fractures of the coronoid process of the lower jaw are extremely rare. Fractures of the neck of the condyle show a depression in front of the external meatus, and on palpation the condyle is not felt to follow the movements of the jaw. The chin is displaced toward the side of the injury, because the lower fragment is pulled upward and inward.

FIG. 49.—METHOD OF GRASPING JAW (LOWER), IN ORDER TO DETERMINE FRACTURES OF THE LOWER JAW.

The thumbs of both hands are placed inside of the mouth on either side of the fracture line, the remaining fingers being placed on the lower border externally, the two fragments are then moved against each other in upward and downward directions alternately.

DISLOCATION OF THE JAW.

These are usually bilateral. The characteristic position of the mouth is well shown in Fig. 49. The lower jaw projects in front of the upper. The mouth is open. There is a depression in front of the ear, correspond-

ing to the glenoid cavity, and the condyle can be felt just below the

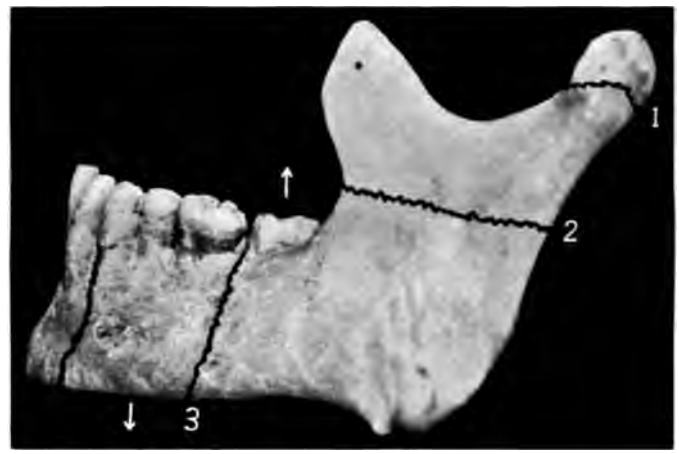

FIG. 50.—LOCATION OF MOST FREQUENT FRACTURE LINES OF VARIOUS PORTIONS OF THE JAW.

1, Fracture of condyloid process extending into temporo-maxillary joint; 2, fracture of ramus of jaw; 3, fracture close to junction of ramus and body. The white arrow to the right of 3 shows the direction in which the masseter muscle pulls the proximal fragment upward, and the arrow to the left of the 3 shows the direction in which the muscles attached to the lower jaw close to the median line pull it downward.

FIG. 51.—FORWARD DISLOCATION OF JAW.

1, Condyle resting upon, or in front of articular eminence; 2, note forward displacement of teeth o lower jaw.

zygoma. There is great difficulty in deglutition, and the masseter and temporal muscles are very tense.

In unilateral dislocations all of these signs are less marked, the chin is pushed over to the non-dislocated side, and the above signs are present only on one side of the face.

DISEASES OF THE SOFT PARTS OF THE FACE.

INFECTIONS.

Erysipelas constitutes the most frequent form of infection of the soft parts of the face with which the surgeon has to deal. It follows eczema and fissures of the mouth, nose, or ears. It may occasionally begin as an erysipelatous angina or sore throat and later spread to the face. The primary pharyngeal cases are extremely serious and are not infrequently followed by meningitis.

FIG. 52.—SWELLING OF THE FACE IN ERYSIPELAS.

In this case the swelling over the eyelids and edema and tenderness over the frontal sinuses were so marked as to simulate a bilateral sinusitis.

The diagnosis of facial erysipelas does not differ from that of the same disease in other parts of the body. The chief characteristic is the bright, glistening redness, which causes the skin of the face to be glazed and shining. There is distinct swelling over the erysipelatous area. If the finger is passed from the neighboring healthy skin across the boundary line, one can notice a distinct elevation of the skin. One can also feel the tense infiltration of the infected skin. The fact that the swelling scarcely pits on pressure, and that the redness cannot be caused to disappear quite as rapidly on pressure as in the case of the redness due to an ordinary phlegmon or infection of the subcutaneous tissue and the sharply outlined edges, serve to distinguish erysipelas from a phlegmon.

The border line of the erysipelatous area is especially to be observed where a question arises as to whether erysipelas or an ordinary phlegmonous inflammation is present. This border line shows distinct demarcation from the healthy skin. It shows outrunners or projections along its entire length, giving it a jagged or irregular appearance.

In cases of phlegmon, this border line does not exist, and there is a gradual shading off of the redness of the skin into the surrounding area.

In phlegmonous inflammation the redness is also of a darker reddish-blue tint, and the induration is more marked owing to the involvement of the deeper tissues.

In erysipelas of the face, as of the head, the presence of numerous blisters or bullæ often assists in making the diagnosis.

If the erysipelas involves the upper portion of the face it may cause intense swelling of the eyelids (Fig. 52). The illustration referred to was taken from a case of facial erysipelas, with meningeal involvement and great tenderness over both frontal sinuses, so that the question arose, as it frequently does, of whether an empyema of both frontal sinuses might be present with secondary infection of the skin. A frontal sinus empyema can be differentiated by the fact that the swelling of the upper lid is usually greater than that of the lower; there is more local tenderness and the temperature as a rule is higher than it is in erysipelas. The pulse is also slow as compared with other septic infections.

A furuncle of the nose or of the upper lip may give rise to a confusion in diagnosis, since the redness and infiltration greatly resemble, in the earlier stages, that of the ordinary facial erysipelas. A furuncle can be readily differentiated from erysipelas by a careful search for a suppurating point, either on the inside or the outside of the nose, or upon the upper lip. In a furuncle of the upper lip the infiltration is usually board-like and brawny, and there is always considerable involvement of the entire thickness of the lip, with edema of the mucosa beneath it.

In the case of furuncles of the nose, especially those of the inner aspect, the diagnosis is much more difficult. It may be made (*a*) from observation of the course of the case; (*b*) from the fact that the redness does not spread as rapidly as in erysipelas, and also by observing the peculiar glistening redness of erysipelas and the sharply marked irregular borders just described.

Malignant pustule upon the nose, due to anthrax, may rarely give rise to confusion. This is also, as is the case with furuncles, readily to be differentiated, by the fact that palpation shows that the swelling of anthrax is very firm, and that there is a central, depressed scar. A bacteriological examination of the pus will readily serve to distinguish the anthrax infiltration from an erysipelas.

When erysipelas is complicated by meningitis there is accompanying delirium, the pulse and temperature both rise, and there are the other symptoms of infective meningitis referred to on page 91.

Furuncles of the Face.—There is usually no difficulty in making a diagnosis of a furuncle of the face, owing to the fact that the soft parts around the original atrium of infection are densely infiltrated and the swelling is board-like in consistency.

In furuncles of the side of the nose there is often quite marked edema of the eyelids and adjacent portions of the cheek. In furuncles of the upper lip the swelling is at times enormous, and the diagnosis may be readily made from the location of the swelling and the detection of a pus focus. In the later stages there is distinct fluctuation present.

FIG. 53.—SWELLING OF LIP IN A CASE OF FURUNCLE OF THE LOWER LIP.

The black area along the lower edge of the vermilion surface indicates the purulent focus.

The onset of complications of furuncles of the face, especially of the upper lip, such as a thrombophlebitis of the facial vein, resulting in a thrombosis of the cavernous sinus, may be suspected when the veins become markedly dilated toward the inner angle of the eye or root of the nose, accompanied by swelling. This is soon followed by the ordinary signs of thrombosis of the cavernous sinus, both local and constitutional, referred to on page 94.

Meningitis as a complication of furuncles, and other forms of infection caused by the ordinary pyogenic organisms in the face, may be suspected by the persistence of fever, increase of pulse-rate, delirium, stupor, and other symptoms of an infective meningitis.

Extensive phlegmons of the soft parts of the face, extending down to the neck, may occur secondary to periosteal abscesses from carious teeth, or rarely after a suppuration of the lymph-nodes situated within the substance of the cheek. The diagnosis can be made from the extensive swelling and other signs of deep-seated infection, such as high temperature and pulse-rate, local redness, etc. In every such case the mouth

should be inspected at once, as this is the source of infection in the majority.

In phlegmons of the deeper tissues of the face there may be thrombophlebitis of the pterygoid veins (Fig. 28), which may spread to the cavernous sinus, causing infective thrombosis of this structure, with all of the characteristic signs of this condition.

Infection of the soft parts of the face may spread to the interior of the orbit, and the question may at times arise as to whether a thrombosis of the cavernous sinus is present, or an orbital phlegmon. In the latter disease, there is less dilatation of the supraorbital, angular, and frontal veins. The headache is supraorbital, rather than deep-seated. In both conditions the exophthalmos and swelling of the lid and conjunctiva are quite marked. There is choked disc or optic neuritis in a sinus thrombosis.

FIG. 54.—BLASTOMYCOTIC DERMATITIS OF THE FACE. Observe the typical wart-like elevations.

In orbital phlegmon, on the other hand, the changes in the fundus are but little marked.

Noma.—The diagnosis of noma may be made from the fact that it accompanies either the infectious diseases, such as measles, scarlet fever and typhoid, or marantic conditions in adults or children. It begins on the mucosa of the cheek or lip as a vesicle, but is soon followed by a black slough, whose situation is usually on the inner side of the cheek and extends through the entire thickness of this part of the face. It is complicated by severe septic disturbances, about 70 per cent. of the cases dying of sepsis. There is usually no difficulty in diagnosis, when one considers the accompanying diseases or conditions and the characteristic sloughing and septic symptoms.

Lupus.—Lupus vulgaris exists more frequently on the face than in any other part of the body. It involves especially the nose, the lips and the cheeks, and is irregularly scattered over these parts. It destroys the tip and wings of the nose, and through its cicatrization may produce ectropion.

The diagnosis may be made from the presence of raspberry-red, pinhead-size nodules situated just beneath the epidermis. At times it is followed by carcinoma, which may be suspected when a papillomatous change takes place in the lupus area, with gradual extension of induration (Fig. 55).

Syphilis.—This rarely appears as a primary form, except upon the lips (page 115). The chief form of surgical interest is the tertiary or gummatous ulceration which may be mistaken for a beginning epithelioma of the face. It appears in the form of round and serpiginous ulcerations, not infrequently multiple, which are situated upon the cheeks, especially at the junction of the nose and cheeks.

FIG. 55.—EPITHELIOMA OF THE FACE DEVELOPING ON LUPUS VULGARIS. (Greensfelder.)

Observe how the alæ nasi have been destroyed by the long-existing lupus: *L*, Lupus nodules; *E*, cauliflower-like epithelioma.

A diagnosis can be made from the history of a preceding syphilitic infection, by an examination of the remainder of the body, and from the characteristic appearance of the broken-down gummata themselves. The outline of the ulcers is often serpiginous or round, the borders are not elevated, as in the case of a carcinoma, the induration is moderate, and not to be compared with that of the ordinary form of epithelioma. The edges are quite steep, as if cut out with a die, and the floor of the ulcer is covered with flabby granulations and necrotic, sloughing masses. There is usually but little, if any, enlargement of the cervical lymph-nodes. Tertiary syphilitic ulcers are quite frequently found upon the forehead, where they are accompanied by necrosis of the frontal bone (Fig. 34).

A differentiation from the slow-growing form of epithelioma, also called rodent ulcer, may be made by the fact that this latter process

shows but little induration of the edges or tendency to ulceration in the earlier stages. Its course is very chronic, so that the breaking down of tissue progresses very slowly, one portion showing cicatrization while another shows ulceration, and there is an absence of a history of primary syphilitic infection.

Actinomycosis of the Face.—This usually causes one of two conditions, (*a*) soft nodules, which fluctuate distinctly and sooner or later break down, giving rise to sinuses from which a brownish pus is discharged, and containing actinomyces. These latter organisms can be recognized by the naked eye as fine, yellowish granules.

FIG. 56.—FRONT VIEW OF SADDLE-NOSE DUE TO TERTIARY SYPHILIS.

Note that the falling-in has taken place at the lower end of the quadrilateral nasal cartilages, owing to destruction of the cartilaginous septum nasi.

FIG. 57.—SIDE VIEW OF SADDLE-NOSE CAUSED BY TERTIARY SYPHILIS.

Note the beginning of depression at the level of the lower portion of quadrilateral nasal cartilages.

(*b*) If the disease is more extensive it causes an infiltration of the deeper tissues of the face, especially of the masseter muscle, giving rise to a board-like hardness, resembling a sarcoma until softening occurs.

Actinomycosis should be thought of whenever abscesses recur in the face from time to time, and there is an absence of suspicion of tuberculosis. One should never neglect, under these circumstances, especially if there is the history of a recurring dental abscess, to search for the actinomyces.

The question may arise of making a differential diagnosis between actinomycosis and [illegible]philis. In actinomycosis there are pockets of pus, or undermined [illegible]lled with flabby granulations and surrounded

by smaller or larger abscesses. Syphilis can be differentiated by not finding the organisms of actinomycosis and by the sloughing condition of the floors of its ulcers. The edges of the latter are quite steep and sharply cut.

Symmetrical Disease of the Lachrymal and Salivary Glands.—This disease, which was first called "Mikulicz's disease," consists in an infiltration of the connective tissue of the lachrymal and salivary glands on both sides of the face with lymphoid cells. The tumors are quite firm, there are no inflammatory symptoms, and the diagnosis can be made from the symmetrical enlargement of the lachrymal, parotid, and submaxillary glands.

It belongs to the class of infectious diseases, and bears some relation to the leukemic processes.

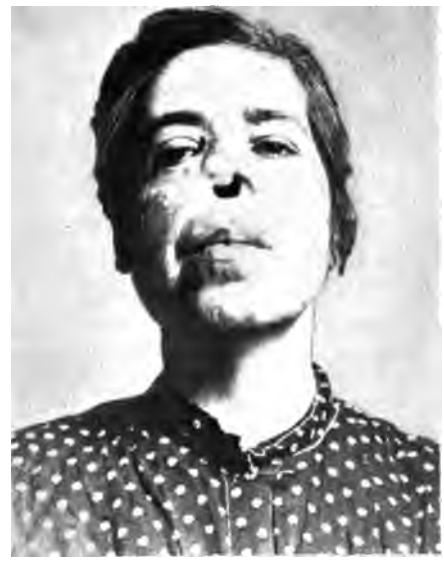

FIG. 58.—NASAL DEFORMITY DUE TO SYPHILIS.

In this case the cartilaginous and bony septum was completely destroyed, allowing the nose to fall in, and the two nostrils to become fused into one opening. There is scarcely any trace of the alæ nasi.

NEOPLASMS OF THE FACE.

BENIGN TUMORS OF THE SKIN OF THE FACE.

Angiomata.—The most frequent benign form is the capillary nevus, which appears as one or more small, raspberry-red, slightly elevated soft areas. It may involve an entire half of the face. It may combine with a second form of vascular tumor, in which the veins are involved, the so-called venous form of angioma, or this latter form may exist alone. If they are combined, the diagnosis may be made from the fact that the swelling is much greater than would exist in the case of an ordinary nevus involving only the capillaries. The whole mass can be caused to disappear on presusre, but returns readily to its original size (Fig. 59). It increases in size when the child cries.

If the venous form exists alone, the tumors are quite soft, the skin over them is bluish in color, and the entire tumor can be caused to disappear upon pressure, but recurs as soon as the pressure is relieved. They are often associated with lipomata, especially in the parotid

region, and this combination should be suspected when the tumors are much larger than could be accounted for by the presence of a venous angioma alone.

Angiomata involving the arteries (cirsoid aneurysm) occur in the frontal and occipital regions. Their characteristics were referred to in the description of the same condition in the temporal region of the scalp (page 74).

Traumatic aneurysms are quite rare in the face and show the same signs as elsewhere.

Sebaceous cysts are not as frequent in the face as in the scalp and show some differences. They are usually adherent to the skin, are rounded, cause less elevation of the skin overlying it, are less firm, and show more fluctuation than is the case in similar tumors of the scalp.

FIG. 50.—ANGIOMA OF THE PAROTID REGION

Lipomata.—These occur in the forehead or deeply in the tissues of the cheek. In the latter position they may be of slow development and must be differentiated from chronic tuberculous abscesses and cystic tumors. This can be done by the fact that lipomata are much more apt to be lobulated in structure and the fluctuation is very indistinct.

Dermoid Cysts.—These are found in the outer fourth of the upper eyelid, less frequently at the inner canthus or at the root of the nose (Fig. 33). They can be readily distinguished from sebaceous cysts by the fact that they are not adherent to the skin, are usually immovable upon the skull, and by their characteristic location. Their differentiation from meningocele was considered on page 73, in connection with the latter form of swelling.

Fibroma molluscum occurs on the face usually in connection with the same condition elsewhere.

Adenomata of the sweat and sebaceous glands occur especially

around the sides of the nose, as soft, flat tumors, which may become pedunculated and bleed readily. They occur above middle age and are much softer and slower in their growth than epitheliomata. Not infrequently carcinomatous changes occur in these sebaceous and sweat adenomata.

Lymphangiomata usually occur in the cavernous form in the cheeks. They may form enormous tumors, which penetrate the entire thickness of the cheek and hang down as soft masses almost to the middle of the neck. They occur most frequently in children and may be differentiated from the venous forms of angioma by the absence of the peculiar

FIG. 60.—ANTERIOR VIEW OF CASE OF LYMPHANGIOMA OF THE CHEEK.

FIG. 61.—SIDE VIEW OF LYMPHANGIOMA OF CHEEK. SAME CASE SHOWN IN FIG. 60.

bluish color of the skin, and the fact that the hemangiomata seldom reach the size of the lymphangiomata (Figs. 60 and 61).

Malignant Tumors of the Skin of the Face.—These include carcinoma and sarcoma. *Carcinoma* appears as a primary form, either as a rodent ulcer or as the ordinary type of epithelioma. The characteristics of the rodent ulcers are that it first forms a crust and then a flat ulcer, which cicatrizes here and there. Its growth as a rule is very slow, but at times it may take on a more malignant form and cause extensive ulceration, destroying all the tissues in its path (Fig. 60). In its earlier stages, when it exists as a flat ulceration, it must be differentiated from the flat, ulcerating forms of lupus. This can be readily

FIG. 62.—EXTENSIVE DESTRUCTION OF FACE IN CASE OF EPITHELIOMA, EXPOSING LEFT SIDE OF BONE, ETC.
T, Middle turbinated bone.

done by the fact that the ulcers of lupus usually show undermined edges, and there are evidences of lupus elsewhere on the face. From syphilis it can be distinguished by the fact that the edges of a syphilitic ulcer are quite sharp or steep, there is more sloughing, and there is either the history or the presence of syphilis elsewhere.

Ordinary *epithelioma* appears comparatively rarely on any other part of the face except the lips (Fig. 62), and this will be considered later. As a secondary form it may be the result of the extension of carcinomata from the jaws or interior of the mouth.

Sarcoma appears chiefly as the pigmented variety or melanosarcoma, arising from the pigmented moles which are so frequently present in the face.

FIG. 63.—EPITHELIOMA OF SKIN OF FACE JUST BELOW AND INVOLVING LOWER EYELID.

TRIGEMINAL NEURALGIA.

The diagnosis of this disease can be made from the history of constant or recurrent pains in a portion of, or over the entire area of distribution of the trigeminal nerve. The pains are lightning-like, beginning after the least irritation. At first the intervals are of considerable duration, but later

these become shorter, until the pains are almost continuous. The diagnosis may be made from the fact that the pains occur at first along

FIG. 64.—DOUBLE HARELIP AND CLEFT PALATE IN NEWBORN CHILD.
Associated with microcephaly and supernumerary digits. Note the protruding intermaxillary bone and the skin covering it.

FIG. 65.—CONGENITAL SUPERNUMERARY DIGIT ON EACH HAND IN A NEWBORN BABE.
This child also had six toes on one foot, and a double harelip and cleft palate as shown in Fig. 64.

one filament, and later along all of the branches of the trigeminal nerve. In addition, there is usually pain on pressure over the points of exit of the three principal branches of the nerve, supraorbital, infraorbital, and mental. This can be elicited by moderate pressure over the nerves at their points of exit (Fig. 9).

In searching for a cause, one should consider whether the disease is of peripheral or central origin. If of peripheral origin there is usually the history of the disease having begun in one branch of the nerve and later involved the other branches.

One must search for peripheral causes, such as carious teeth, diseases of the jaw bones, tumors, chronic empyema of the frontal sinus or antrum, fractures and various constitutional causes, such as chlorosis, toxemia from malaria, or syphilis.

Among the central causes may be mentioned cerebral syphilis, aneurysm of the internal carotid artery, and tumors of the brain.

If both central and peripheral causes are eliminated, the disease is in all probability a reflex one.

FIG. 66.—DOUBLE CLEFT PALATE AND HARELIP.

View of interior of mouth: *P*. Skin in median line covering the intermaxillary bone, the projecting portion of the latter being seen immediately below it; *M*, intermaxillary bone; *C*, *C*, palatal processes of the right and left superior maxillæ respectively; the black space between *C* and *M* on each side of the median line represents the cleft in the palate; *L*, *L*, right and left lips respectively. Note the cleft between these rudimentary lips and the central portion of the lip (*P*), covering the intermaxillary bone. *T*, Tongue. This photograph was taken while the child was crying.

DISEASES OF THE MOUTH AND PALATE.

Malformations of the Lips.—The most frequent congenital malformation of the lip is "harelip." The diagnosis of this is easy (Fig. 66). It may involve simply the vermilion or red border of the lip, or extend through the entire thickness of the lip, either on one or both sides of the median line. If unilateral, it is usually found on the left side. It causes a widening of the nostril of the corresponding side. If bilateral, there is associated with it the most frequent congenital malformation of the palate, viz., cleft palate (Figs. 64 and 65). In such cases the inter-

maxillary bone separates the double cleft in the palate and may project between the two clefts in the lips, being covered by a flap of skin, which is continuous with that of the median line of the nose. In many cases the intermaxillary bone is markedly prominent.

Acquired malformations of the lips most frequently follow extensive burns or operations. In many cases the opening of the buccal cavity is congenitally narrow, giving rise to a condition known as microstomia.

FIG. 67.—ENLARGEMENT OF THE LIPS DUE TO ADENOMATA OF THE MUCOUS GLANDS (MACROLABIA).

The enlargement is most marked in the upper lip on either side of the depression seen in the median line. In addition, this patient had a double ptosis.

THE LIPS.

The most frequent conditions calling for diagnosis in the lips are herpes, enlargement of the lips (macrolabia), and ulcerations of the lip, due to syphilis, carcinoma, benign and malignant warts, or papillomata.

In regard to **herpes,** the chief point of interest is the fact that it usually occurs at the angle of the mouth, consisting of a group of vesicles which are often symmetrically situated on both lips. When ulcerated, that is, when the vesicles burst, they may be mistaken for either primary or secondary syphilis. This will be referred to below.

Macrolabia may be due to one of three conditions: *(a)* In tuberculous children the lip is often greatly thickened and is accompanied by more or less inflammatory signs. The condition is a chronic one, growing slowly in until the lip is greatly increased in thickness, and recurring from time to time. *(b)* In abnormal thickening of the lip due to lymphangioma, the lip is fairly firm, the enlargement is uniform, there is more or less connective-tissue formation, and the enlargement involves the entire thickness of the lip. *c.* A third form of macrolabia is that due to a primary adenoma of the mucous glands of the lip. The lip is soft, the enlargement is most marked in the upper

FIG. 68.—METHOD OF EVERTING LOWER LIP IN ORDER TO OBSERVE A CARCINOMA OF THE WARTY TYPE OF THE INNER ASPECT OF THE LIP.

FIG. 69.—GUMMA OF LIP IN A MAN OF THIRTY-TWO.
Showing extensive destruction on inner aspect. Lip has been artificially everted.

lip (Fig. 67), and often one can feel a series of shot-like nodules through the stretched mucous membrane.

Both hemangioma and lymphangioma are usually congenital conditions in the lips or appear in early infancy. Tuberculous thickening of the lips is associated with evidences of the same disease elsewhere, in the form of tuberculous glands of the neck, etc. What was formerly called "scrofulous thickening" of the lip is rarely seen at

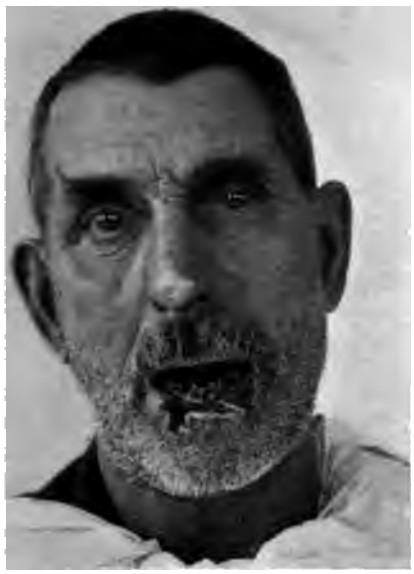

FIG. 70.—EXTENSIVE DESTRUCTION OF LOWER LIP CAUSED BY EPITHELIOMA IN A PATIENT SIXTY YEARS OF AGE.

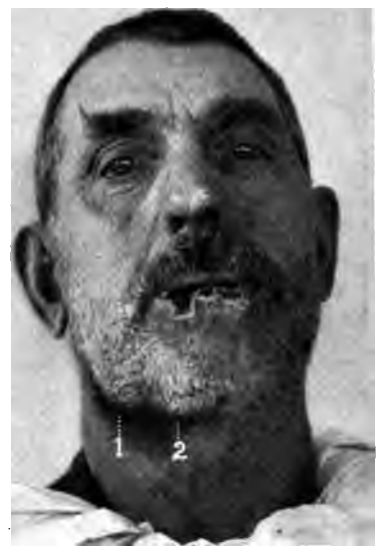

FIG. 71.—EPITHELIOMA OF LOWER LIP; SAME PATIENT AS SHOWN IN FIG. 70.

This illustration shows the most frequent localization of the regional lymphatic infection, namely, in the submaxillary (1) and submental (2) lymph-nodes.

the present day. Primary adenomatous thickening occurs after puberty.

Syphilitic ulcerations of the lips are present either in the form of primary chancres or as broken-down gummata. In the case of chancres, one finds an ulcer with steep edges; there is marked induration around the edges, the floor is covered with a dirty slough or necrotic granulations, and the process is usually quite limited, involving, however, almost the entire thickness of the lip at the vermilion border. It is accompanied by rapid enlargement of the submental and submaxillary lymph-nodes on the side of the lip upon which the chancre is situ-

ated. The induration is never as marked as in carcinoma. Chancre appears, as a rule, in younger persons, and the further observation of the case with the appearance of secondary symptoms will soon clear up the diagnosis. It may be stated that the enlargement of the lymph-nodes in chancre of the lip is far greater, as a rule, than in carcinoma, with which it may be confused in some cases, but the lymph-nodes themselves are not as firm and indurated, and are softer in consistency. The question may at times arise as to whether an ulcer of the lip is due

FIG. 72.—METHOD OF EXAMINATION IN ORDER TO DETERMINE ENLARGEMENT OF THE SUBMAXILLARY OR SUBMENTAL LYMPH-NODES.

The examiner should stand in front of the patient, or both may be seated face to face. The patient should be instructed to relax the muscles which pass from the lower jaw to the hyoid bone by flexing the head upon the neck while the finger-tips of the examining hand are inserted for a considerable distance further than if the head were extended.

to the ulceration of the vesicles of a herpes labialis. In the latter case there is no induration, and recovery should occur within one to two weeks under ordinary treatment.

Gummata of the lip appear quite rarely, but must be borne in mind in considering the differential diagnosis of carcinoma of the lip. Gummata are not accompanied by any enlargement of the lymph-nodes and are painless. The infiltration often involves the entire lip, although the ulceration may be quite localized. There is not the marked indura-

tion which is characteristic of carcinoma, and a week of administration of the iodid of potassium in moderate or large doses will soon clear up any doubts in diagnosis.

Epithelioma of the lip may appear in a number of different forms—first, as a wart (Fig. 68), whose base becomes indurated, the papillomatous surface rapidly enlarging, and the induration extending; second, it may appear as an ulcer which shows the following characteristic signs: it involves the entire thickness of the lip (Fig. 70); its edges and base are markedly indurated; there is no necrotic sloughing floor, as in a gumma or chancre. An examination of the submental and submaxillary lymph-nodes (Figs. 71 and 72) will show an enlargement of these nodes at a comparatively early period in carcinoma. In gummata there is no enlargement, while in chancres they are softer and larger.

Carcinoma of the lip almost invariably invades the lower lip and occurs most often in men; only 3 in 350 cases occurred in females.

DISEASES OF THE JAWS.

TUMORS OF THE JAWS.

The most convenient division of tumors of the jaws is into those (*a*) having their origin in some structure connected with the developing or mature tooth; these are termed odontogenous tumors, while the second class, (*b*) having their origin in structures not related to the teeth, are called nonodontogenous tumors.

Odontogenous.—(1) Simple cysts. (2) Dentigerous cysts. (3) Benign central epithelioma: (*a*) Adamantinoma; (*b*) Multilocular cystoma. (4) Odontoma. (5) Congenital epulis.

Nonodontogenous.—(1) Fibroma. (2) Chondroma. (3) Myxoma, lipoma, angioma. (4) Osteoma. (5) Sarcoma. (6) Epulis tumors. (7) Carcinoma. (8) Endothelioma or mixed tumor of hard palate.

ODONTOGENOUS TUMORS.

1. **Simple Cysts.**—These usually occur in adults (twentieth to thirtieth year). Witzel found 76 in the upper and 29 in the lower jaw. They usually occur on the bicuspids and molar teeth. They arise from granulomata which form at the root of these as the result of caries. The cysts develop within the granulation tissue of which the granulomata are composed. The original source of these granulomata is in the enamel organ of the developing tooth. As the cysts increase in size they cause early bulging of the anterior wall of the jaw. Usually the wall

over the cysts is smooth and hard, but it may be thin and give the peculiar parchment-like crepitation so often seen in dentigerous cysts. Palpation of the surface gives no clew as to the size of the cyst, as they may develop into the antrum and occupy its entire cavity. The most important point in the diagnosis of these simple or root cysts (Wurzelcysten) is to demonstrate the presence of the carious tooth. The fluid they contain is clear yellow, and contains cholesterin crystals. A skiagraph of the jaw is also of great aid in making the diagnosis. When such cysts become infected, there is severe pain, swelling of the soft parts, and rise of temperature. The simple cysts must be differentiated from dentigerous cysts, chronic periosteal abscess, central jaw tumors, and empyema of the antrum. In an abscess there is more swelling of the soft parts, while in a cyst the mucosa is smooth and slides over it. The cyst is more sharply demarcated, painless, and of slow growth. Central tumors do not have a smooth, parchment-like surface like the cysts. In extreme cases exploratory puncture will decide. True empyema of the antrum causes no expansion of the bone and never perforates spontaneously. Dentigerous cysts occur at a much earlier age and there is no carious tooth present..

2. **Dentigerous Cysts.**—The appearance of a semifluctuating unilateral tumor on the outer side of the upper or lower jaw of a child between seven and fourteen years, should lead to the suspicion of a dentigerous cyst. They develop in connection with the eruption of the permanent teeth, and contain either a rudimentary or fully developed permanent tooth, and there is usually a corresponding tooth missing in the row of teeth. The outer surface is usually hard, but it may feel like a freshly broken egg shell, giving a peculiar crackling sensation, and the contents of the cysts is a clear mucoid fluid. In the lower jaw they protrude externally, while in the upper they may bulge into the antrum. At times they appear in children as a recurrent dental abscess which does not heal until the sac is extirpated and the permanent tooth removed. Under these conditions they may even penetrate the cheek like ordinary dental abscesses of the upper jaw (Fig. 105). As a rule, they grow slowly, but may develop to the size of a walnut within a few days.

The diagnostic features are the age, development on the outer side of jaw, semifluctuation, egg-shell crackling, missing tooth and clear yellow contents.

They must be differentiated from the following:

(*a*) *Sarcoma.*—The growth is more rapid; they break through the bone shell early, and one feels the soft tumor mass, if of the soft variety. If of the chondro- or osteosarcomatous type, there is no difficulty in

differentiation because these are much firmer than a dentigerous cyst.

(*b*) *Fibroma.*—The diagnosis from dentigerous cysts must be taken into consideration, both in central and periosteal fibromata. The latter are quite rare, and are much smaller and firmer than the cyst. Central fibromata cannot be diagnosed until the bone begins to be expanded (Fig. 74). The growth is quite slow, and, if there is only a shell of bone covering it, one does not get the semifluctuant sensation of a dentigerous cyst, the tumor feeling much firmer. In case of doubt an exploratory puncture and the absence of fluid can be demonstrated. Again, an

FIG. 73.—OSTEOMA. (International Text-Book of Surgery.)

x-ray picture will show a shadow corresponding to the tooth, lying in the sac, in the case of a dentigerous cyst.

3. **Multilocular Cystoma and Solid Central Epithelioma.**—Both of these are derived from the enamel organ. The formation of cysts does not distinguish, since there is no tendency to it in the benign epithelioma form. This latter is made up of a solid tumor mass composed of columns of tissue which are covered with cylindrical epithelium. Only nine cases where it has occurred in the lower jaw and four of the upper jaw have thus far been reported (Perthes[1]). It has been called adamintoma or epithelioma adamantinum. It is a benign form of tumor, occurs

[1] "Deutsche Chirurgie," "Krankheiter der Kiefer."

only in adults, and is well encapsulated. Its growth is much slower than that of a sarcoma, it causes less regular expansion of the bone, and it

FIG. 74.—VIEW OF LOWER JAW IN A CASE OF CENTRAL FIBROMA.

leaves the mucosa intact. In such an adamantinoma a system of smaller and larger cysts may develop and grow to enormous size. Few cases have thus far been reported. A skiagraph will show a tumor with multiple cysts and the presence of an abnormal tooth. It, like the adamantinoma, grows very slowly and causes irregular expansion of the bone. It is the only variety of multilocular cystic tumor occurring in the jaws. The surface is often quite thin and parchment-like. Neither simple or dentigerous cysts ever attain the size of these multilocular cysts. The dentigerous cysts occur at a much earlier age, as a rule.

FIG. 75.—EPULIS (Edmund Owen).

4. **Odontomata.**—These are divided into those which are not adherent to the teeth (independent) and those which are so adherent (crown and root odontomata). The former

never grow very large, are always encapsulated, and their surface is hard and nodular. Only 23 cases of this variety have been reported (Perthes). Of these, 19 were in the lower jaw around the molar teeth. They may develop unnoticed or with neuralgic pains. Infection occurred in the majority of the reported cases, with high fever, edema, and severe pain. It resembles a dentigerous cyst in many ways, *e. g.*, the youthful age, expansion of bone without involvement of skin or mucosa. The surface of the odontoma is more nodular and harder. The *x*-ray was of great value in diagnosis in two of Perthes' cases.

NONODONTOGENOUS TUMORS.

Fibromata.—These may either have their origin in the periosteum or in the central portions of the jaw. The former are more frequent, only eleven cases having been reported of the latter. Both the central and periosteal forms occur between the ages of sixteen and thirty-five. The periosteal can be recognized clinically as a small, hard tumor, called fibrous epulis, growing from the periosteum at the margin of the alveolar processes, usually of the lower jaw. The central form cannot be recognized until it has grown to a sufficient size to have caused expansion of the bone overlying it. They occur almost exclusively in the lower jaw, and until there is a prominence over the bone (Fig. 74) the patient is not aware of its presence unless exceptionally it presses upon the mental nerve. Parchment-like crackling, so frequently observed in the other forms of tumors of the jaw, is very rarely present, only once in eleven cases. As a rule, the cortex of the bone is intact. The chief conditions from which these fibromata must be differentiated are in the case of a periosteal fibromata or fibrous epulis, from a periosteal sarcomata or sarcomatous epulis. The consistency of the latter is softer, as a rule, and the growth is more rapid than in the case of a fibroma. The

FIG. 76.—SARCOMA OF THE ANTRUM. (International Text-Book of Surgery.)

central fibromata, after they have caused sufficient expansion of the bone to be recognized, must be differentiated from the central form of sarcomata. As a rule, central fibromata do not grow as rapidly as the same form of sarcomata, nor do they give rise to egg-shell crackling sensations, or break through the shell of bone in their growth, as do the sarcomata.

There is a rare form of central actinomycosis which may resemble the central fibromata, but in these there is early tendency to softening and perforation of the bone with sinus formation, and the discharge of pus containing yellowish granules with the characteristic organisms.

Chondromata.—Chondromata seldom occur in the jaws as pure cartilage tumors. They are most frequently present in the form of

FIG. 77.—OSTEOMA ARISING FROM ALVEOLAR PROCESSES OF LOWER JAW.

chondrosarcomata or osteochondromata, which are allied to the sarcomata clinically. They occur as central chondromata in both the upper and lower jaws and as periosteal chondromata in both jaws, but especially in the upper. They form hard nodular tumors, which have the characteristic consistency of cartilage. The sensation on palpation can be compared to that felt on pressure over the nasal cartilages. Their growth varies greatly, that of the pure chondromata being very slow, so that the central form cannot be recognized until it breaks through the bone. The more they resemble the sarcomata in histologic structure, the more rapidly do they grow. Both form pedunculated tumors of the gums.

Osteomata.—Osteomata occur most frequently in the lower jaw, although occasionally an osteoma will develop into the antrum of Highmore and give rise to symptoms of pressure upon the infraorbital nerve and gradual bulging of the anterior wall. They may grow also toward the orbital cavity or toward the nose. Both in the upper and lower jaws they can be recognized by their bony consistency and their slow growth. Occasionally osteomata having their origin in the wall of the antrum may be recognized by the *x*-ray, but otherwise the same may be said of this class of tumors as of all the tumors of the upper jaw which originate in the antrum, that they cannot be diagnosed until they grow beyond the walls and cause bulging of the same. One can, however, suspect their presence from the complaint of dull pain over the antrum and, in the case of sarcomata or carcinomata, of escape of blood and mucus from the nose, without the ordinary symptoms of an empyema. Osteomata of the lower jaw must be differentiated from osteosarcomata. If periosteal, they can be readily recognized, sometimes growing to quite enormous size. Their growth, however, is exceedingly slow, and, even though they be central in origin, they rarely cause any atrophy of the overlying bone such as will give rise to egg-shell crackling.

FIG. 78.—TYPICAL ENLARGEMENT OF THE FACE DUE TO TUMOR OF THE LOWER JAW (SARCOMA).

Sarcomata.—Sarcoma is the most frequent form of malignant tumor of the jaws. It may arise from the gums at the side of the tooth, giving rise to a soft, often pedunculated (Fig. 75) tumor, called sarcomatous epulis, which must be differentiated from the ordinary fibrous form of epulis. The fibrous epulis is, however, harder, and is not of a dark bluish-red color like the sarcomatous epulis, and is of much slower growth. The sarcomatous epulis has its origin in the periosteum of the alveolar process. It occurs between the ages of ten and twenty and always shows the structure of a giant-celled sarcoma. The pure spindle, round-celled or fibrosarcomatous types are quite

rare. They bleed readily, are ulcerated, cause no pain and do not recur, as a rule, after removal. There is also but little tendency to cause expansion of the bone. Another variety of tumor[1] must sometimes be differentiated. This is not a true tumor, but simply a mass of granulation-tissue which may arise in the cavity from which either a tooth has been extracted or in which a carious tooth lies. It is composed of flabby, edematous granulations, and has a narrow pedicle, which can be traced up into the cavity occupied by the extracted or carious tooth. It is much softer than the sarcomatous epulis and can be readily recognized as composed of granulation-tissue. It can be differentiated from the sarcomatous epulis by the fact that the latter is firmer than this granuloma. Both the granuloma and sarcomatous epulis bleed easily. The history will also show that the sarcomatous epulis has grown more rapidly than the granulation-tissue tumor, spreading over several alveoli, and not being confined to a single alveolus, as is the case in a granuloma.

FIG. 79.—RECURRENT OSTEOSARCOMA OF THE SUPERIOR MAXILLA.

This illustration shows the typical site of tumors of the upper jaw which protrude externally, showing how they involve the surrounding osseous and soft structures. The curved line indicates incision of first operation.

The central sarcomata begin either in the body of the lower jaw or in the bone surrounding the antrum of Highmore in the upper jaw.

The diagnosis of such a central sarcoma of the upper jaw can only be made, as a rule, when the growth has caused expansion of the over-lying bone. If the tendency of the growth is toward the nose, it has at times been treated for a polyp. Usually it grows toward the face, and causes a prominence of the cheek, pushes the eyeball up, and, if it develops toward the palate, causes a bulging in the latter.

In the lower jaw these central sarcomata cannot be recognized until the bone has been expanded by the rapidly growing tumor (Fig. 78).

[1] The term epulis means a tumor of the gums and has of late years only been applied to the fibromatous and sarcomatous varieties.

All types of sarcomata, including the endotheliomata, may occur, but most frequently one finds the osteosarcomata (Fig. 76).

The diagnosis of these forms of central sarcomata of the lower jaw may be made by the history of a rapid enlargement and the local examination. In the latter one finds an enlargement of the jaw, which is usually marked both on the side toward the mouth and that toward the cheek. In the softer varieties there is distinct egg-shell crackling. In the harder forms, with more analogy to the osteosarcomata, the growth is quite firm and bone-like.

FIG. 80.—PRIMARY CARCINOMA OF GUMS OF LOWER JAW WELL SHOWN BY EVERTING LOWER LIP

FIG. 81. — ENORMOUS SECONDARY CARCINOMATOUS LYMPH-NODES OF NECK, FOLLOWING PRIMARY CARCINOMA OF GUMS, SHOWN IN FIG. 73.

In the upper jaw, sarcomata must be differentiated from carcinomata arising from the antrum of Highmore. This cannot be done until the tumor has grown to a sufficient size to be palpated through the mouth. In the case of osteosarcomata or chondrosarcomata, palpation shows them to be much firmer than a carcinoma. Carcinomata tend to ulcerate upon breaking through the walls of the antrum much earlier than is the case with sarcomata.

In regard to age, carcinomata appear at a much later period of life than sarcomata. There is quite early involvement of the regional lymph-nodes (submaxillary and deep cervical) in a carcinoma.

Carcinoma of the upper jaw, as a rule, grows much more rapidly, and is more painful than is the case in sarcomata of the upper jaw.

From fibromata, both of the upper and lower jaw, sarcomata may be differentiated by their more rapid growth and the tendency to invade surrounding structures. The central fibromata of the lower jaw are quite localized, often encysted tumors, which is not the case with sarcomata. From the other forms of benign tumors of the jaws, like chondroma and osteoma, sarcomata may be readily differentiated by their rapid growth. It must be remembered that the pure form of chondroma is comparatively rare, the majority of these being chondrosarcomata.

Carcinoma of the Jaws.—These appear (*a*) either as primary tumors of the gums or growths arising from the mucosa of the antrum of Highmore, or (*b*) as secondary tumors by direct extension from neighboring carcinomatous involvement, either of the mouth or of the face (Fig. 62). The diagnosis of carcinoma arising from the mucous membrane of the antrum can only be made, as was stated above, when the tumor is of sufficient size to grow toward the nose, face, or palate. They usually appear during the later years of life; their growth is quite rapid, much more so than is the case of sarcoma of the upper jaw, and there is greater tendency to ulceration. The most frequent form of carcinoma, however, is that which arises from the mucous membrane of the gums (Fig. 68) or palate, and of this variety those occurring in the upper jaw are more frequent. They almost invariably appear in elderly people in the form of a carcinomatous ulcer which is deeply excavated and has raised, everted, and markedly indurated edges. There is quite early enlargement of the submental, submaxillary, and deep cervical lymph-nodes (Fig. 69). The diagnosis in the earlier stages is not difficult when one considers that all other forms of ulceration which occur at this period of life are not accompanied by enlarged indurated lymph-nodes. Such ulcerations may occur in elderly people as the result of sharp teeth or of an ulcerative stomatitis, as the result of improper care of the mouth. In both of these the ulcers are quite superficial; the edges are seldom indurated, and the ulceration rapidly disappears as soon as the cause is removed.

From tertiary gummata the carcinomatous ulcer can be differentiated by the fact that gummata seldom occur on the jaws except on the palate. There is usually a history of syphilis or the presence of syphilis elsewhere. No enlargement of the regional lymph-nodes occurs and the edges are never as indurated as is the case in a carcinomatous ulcer. The administration of potassium iodid will show a marked improvement if the ulcer is a gumma.

TUMORS OF THE PALATE.

Tumors of the hard palate may be either primary or the result of the extension into the palate of a primary tumor of the upper jaw or of the nasopharynx. Those developing by extension require no special mention. Primary tumors of the palate are usually of the same histological character as the so-called mixed tumors of the parotid and submaxillary salivary glands (page 155). They may attain considerable size, but are very slow in their growth. They do not cause any pain, show no tendency to ulceration, and, as a rule, do not tend to recur after removal.

INFECTIONS OF THE JAWS.

In order to be able to recognize inflammatory processes of the jaws, it is necessary to have a clear conception of their pathology as well as of their clinical appearance.

It is important to determine (*a*) the nature of the process and (*b*) the extent of involvement of the bone.

The ***nature*** of the affection varies somewhat according to the cause. The most important of the latter are:

1. Infection from the teeth.
2. Infection following compound fractures.
3. Tuberculosis.
4. Syphilis.
5. Actinomycosis.
6. Phosphorus necrosis.
7. Acute pyogenic osteomyelitis.

The extent of the process varies according to the cause. In the majority of cases following tooth infection, there is a suppurative periostitis with the formation of subperiosteal abscesses and resultant necrosis of the underlying bone. Such an abscess may form around the root of the tooth (Fig. 82) and remain confined to this location or it may extend to the extra-alveolar portion of the bone. Here its further course varies. In the upper jaw the pus may (*a*) burrow toward the antrum of Highmore (Fig. 82), or (*b*) penetrate the tissues of the cheek and perforate externally, or (*c*) it forms a subperiosteal abscess which causes a swelling at the line of reflection of the gum and mucosa of the cheek.

In the lower jaw the anatomic conditions differ. Here infective processes either form (*a*) an abscess within the alveolus itself around the root of the tooth, or (*b*) it causes a marked periostitis, usually on the outer aspect, or (*c*) the infection progresses to the floor of the mouth

and to the loose cellular tissue of the neck (Fig. 82) and, if not arrested, to the anterior mediastinum.

These various degrees of infection may result in necrosis of the bony structure of a single alveolus or of a number of them. In the lower jaw, the above referred to periostitis of the outer aspect, is either of a plastic nature which undergoes resolution or the infection causes a subperiosteal abscess with necrosis of a lamella or more, of the cortex of the bone.

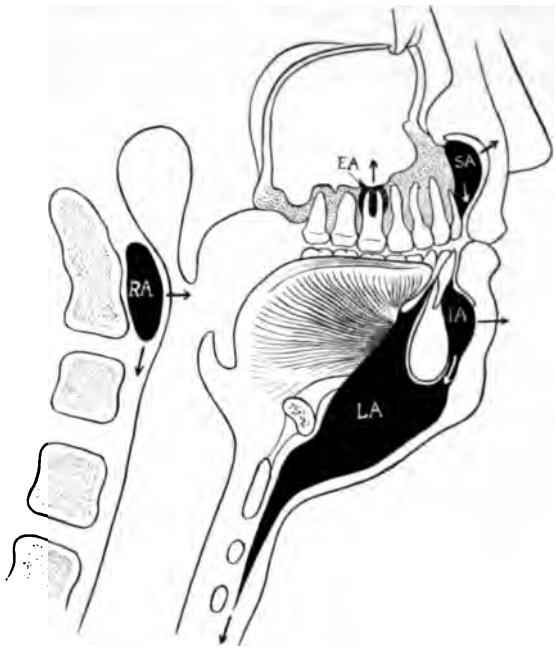

FIG. 82.—SAGITTAL SECTION OF HEAD TO SHOW SPREAD OF SUPPURATION FROM INFECTED TEETH; AND ALSO LOCATION OF RETROPHARYNGEAL ABSCESSES.

SA, Subperiosteal abscess of upper jaw opening toward cheek and mouth in direction of black and white arrows, respectively; *IA*, subperiosteal abscess of lower jaw opening toward submaxillary region and chin in direction of white and black arrows, respectively; *LA*, infection in submaxillary subcutaneous tissue as a result of abscesses arising from teeth and from floor of mouth (this condition is also called angina Ludovici); *EA*, infection around roots of bicuspid and molar teeth spreading toward antrum in direction of arrow; *RA*, retropharyngeal abscesses.

A true osteomyelitis, *i. e.*, an involvement of the medulla of the bone, is very rare after tooth infection.

In compound fractures, tuberculosis, syphilis, actinomycosis, and in infection following the acute exanthematous diseases the pathologic changes differ only in extent from those already described.

The chief diagnostic points of the various inflammatory processes are as follows:

Infection from Teeth.—Abscesses around the root of the tooth cause severe pain referred to the tooth, accompanied by tenderness on pressure, redness, and swelling of the gum. There is always more or less swelling and induration of the overlying skin, especially in the upper jaw, often causing marked edema of the lower eyelid and upper lip. If the infection migrates through the root canal it may penetrate the alveolus and give rise to an abscess beneath the gum (gum-boil), indicated by swelling and fluctuation. If the alveolar process is necrotic, the opening from which the pus escaped

either spontaneously or by incision continues to discharge until sequestration occurs. A fine probe passed through the opening encounters denuded dead bone. If the necrosis involves a number of adjacent alveolar processes there is more or less retraction of the gums, with constant discharge of pus. Upon inserting a probe the extent of the necrosis can be readily determined. In advanced cases the entire alveolous may be necrotic. In children, spontaneous perforation through the cheek over either upper and lower jaws, is frequent. A sinus is present externally along which a probe can be passed until exposed bone is encountered.

In connection with the diagnosis of infection of the upper jaw from carious teeth it is well to call attention to the fact that an empyema of the antrum of Highmore, especially if acute, will cause irritation of the nerves of the bicuspids and first molar, so that these teeth are often thought to be diseased.

FIG. 83.—SUPPURATION OF THE SUBMAXILLARY LYMPH-NODES.

Infection of the surrounding cellular tissue of this region and of the cheek, the latter almost closing the eye, followed tooth infection.

Infection Following Compound Fractures.—Necrosis of the jaw is present in these cases when (*a*) a sinus is found, either within the mouth or externally, which leads to denuded bone at the seat of fracture; (*b*) if abscesses form after a fracture which heal and then fill up again, until a piece of necrotic bone is either removed by operation or spontaneously discharged.

Tuberculosis of the jaws is quite rare. It is most frequently located at the junction of the superior maxilla and malar bone. It causes a swelling along the lower border of the orbit which has all of the clinical characters of a tuberculous or cold abscess. These characteristics are the gradual appearance of a swelling without pain, redness or rise of local or general temperature. The skin over it is bluish a after evacuation of the pus has occurred, a sinus persists whose edges lined by flabby, often caseous, granulations.

Tuberculosis also occurs in the alveolar and palatal processes

in the body of the lower jaw. The diagnosis in these locations can only be made by excluding the other forms of infection and by the peculiarly slow onset.

Tuberculosis of the lower jaw may resemble sarcoma, syphilis and actinomycosis. A sarcoma of the body of the lower jaw grows more rapidly; it is not accompanied by necrosis of the bone, but a gradual thinning of the same (page 124).

Syphilis is rare in the lower jaw and there are usually evidences of the disease elsewhere.

Actinomycosis is not apt to be accompanied by swelling of the lymph-nodes, as is the case in tuberculosis. The pus contains fine yellow granules in which the ray fungus is found.

Syphilis.—In the lower jaw it appears as a periostitis which causes either circumscribed or more diffuse swellings. The diagnosis can only be made if other causes of periostitis, especially those due to tooth infection, are excluded. There is usually, however, a history of syphilis elsewhere.

The hard palate is the most frequent location of tertiary syphilis in the jaws. It causes a painless swelling which opens spontaneously, exposing denuded, often foul-smelling bone. In other cases the patient may present himself for an opinion as to the nature of an acquired perforation of the hard palate.

The alveolar processes of both jaws and of the nasal process of the upper jaw are also frequent seats of syphilis, especially of the type known as the late hereditary, which appears in children at the age of puberty.

A diagnosis of this hereditary form can be made by a careful history, the absence of any other causes of necrosis, and antisyphilitic treatment.

Actinomycosis.—This inflammatory disease of the lower jaw occurs far more frequently than was formerly thought. It almost always follows a primary infection of the gums or mucous membrane of the cheeks, which is rapidly followed by infection of the soft tissues of the face and neck, as described in the chapter upon the neck.

In the jaws, actinomycosis may either appear as an accompaniment of the same affection in the soft parts or as an independent clinical entity. There are two forms, a peripheral and a central, both of which most frequently involve the lower jaw. The peripheral form of jaw actinomycosis either causes a superficial necrosis or multiple abscesses, varying in size from a pea to a hazelnut, filled with soft granulations. In the pus from these latter cavities, the actinomyces are found. These abscesses may first arouse the suspicion of the surgeon or dentist on account of the

absence of acute inflammatory symptoms and the fact that they recur from time to time.

The central variety of actinomycosis of the lower jaw occurs in two forms—(*a*) a penetrating and (*b*) a tumor-like form. In the former there is marked rarefaction without the formation of sequestra, but considerable thickening of the outer layer of bone. This form is very virulent, especially when it affects the upper jaw. The tumor-like form is rarely met with in man, occurring usually in cattle as lumpy jaw. Its course is very slow and results in the formation of multiple cysts.

The diagnosis of actinomycosis of the jaws, as is the case elsewhere, can only be made if the characteristic organism is found. It bears great resemblance clinically to ordinary tooth infections, especially if associated with involvement of the cellular tissue of the neck. The course of actinomycosis is slower, it is more often accompanied by trismus (see page 106), and there is often a history of chewing hay, grain, etc., or of having been around infected cattle.

Phosphorus Necrosis.—Owing to the regulation of the manufacture of matches, this disease is practically extinct. It affects the lower jaw more often than the upper. The clinical picture is that of a suppurative periostitis, but the pus is very foul and necrosis is more extensive than is the case in ordinary tooth infection.

Acute Suppurative or Pyogenic Osteomyelitis.—This rare affection usually occurs in young persons, in the lower jaw. It may follow the acute exanthemata like measles, scarlatina, and variola, or occur simultaneously with acute osteomyelitis of other long bones. In other cases there is no apparent cause.

The diagnosis presents no difficulties. In the milder type the disease more frequently involves the upper jaw. There is gradually swelling of the face over the superior maxilla of one side or over the entire lower jaw with moderate fever. This is followed by necrosis of the entire alveolar process with the loss of the temporary teeth as well as the non-erupted permanent teeth.

In the more severe form, the course is much more like that of the same disease in the extremities. It begins with a chill, followed by high fever and marked increase of pulse-rate. There is extensive swelling and redness of the soft parts over the jaw and severe septic symptoms.

DEFORMITIES OF THE JAWS.

Deformities of the lower jaw occur far more frequently than do those of the upper. Those of both jaws are either primary or secondary in origin. Of the primary forms, those in the lower jaw are as follows:

1. Micrognathism, or abnormally small lower jaw. This may be either congenital or occur during the period of growth of the jaw. If in the latter period, it is often due to an early ankylosis of the temporo-maxillary joint. In some cases almost the entire lower jaw is absent (agnathism). The body is more affected than the ramus. The deformity causes the well-known bird-like appearance of the face with limitation of movement of the jaws.

2. Macrognathism, or abnormally large lower jaw. This occurs far less frequently. The chin is very prominent and the teeth lie in front of those in the upper jaw.

3. Prognathism, or abnormal prominence of the upper jaw, is also rare. Its etiology is unknown.

Secondary deformities occur as the result of scars from burns, macroglossia, wry-neck, nasal stenosis, rickets, cretinism and acromegaly.

DISEASES OF THE TEMPORO-MAXILLARY JOINT.

This articulation is subject to the same forms of inflammation as is the case in the joints of the extremities. These are:

Primary Acute Arthritis:

1. Acute traumatic arthritis (sprains).
2. Acute articular rheumatism.

Secondary Acute Arthritis:

1. Metastatic..(*a*) Through infection with ordinary pus cocci by metastasis from foci elsewhere in the body.
   (*b*) Through infection with gonococci, after scarlatina, typhoid, etc.
2. Direct.....Through extension into the joint from neighboring foci of suppuration.

Chronic Arthritis:

1. Tuberculosis.
2. Arthritis deformans.

Of the above, the acute inflammations are most often a result of acute articular rheumatism or a metastasis from a gonorrheal infection. The diagnosis is not difficult. There are redness, swelling, and pain over the joint, which latter is just in front of the tragus of the ear.

Pyemic inflammation is also not rare. The chronic forms are characterized by pain over the joint upon movements of the jaw, crepitation, and slight swelling. There are two forms of chronic inflammation

of the joint which lead to relaxation of the ligaments and favor subluxation. One of these forms is the result of an arthritis deformans which usually accompanies the same disease in other joints. The movements of the jaw are accompanied by pain and crepitation and are very difficult.

Ankylosis of the Temporo-maxillary Joint.—Trismus (lockjaw) is the name given to inability to open the mouth. It may be congenital or acquired. The following forms exist of the latter: (*a*) A reflex spasm of the masseter muscles following acute inflammatory diseases of the jaws and occurring most frequently during the eruption of the wisdom-teeth—it has been given the name "symptomatic lockjaw"; (*b*) as the first symptom of tetanus (see page 618); (*c*) as a result of acute or chronic disease of the temporo-maxillary joint; (*d*) as a result of cicatrices in the tissues around the joint; (*e*) as a result of disease of the adjacent bones, especially after osteomyelitis of the condyle of the lower jaw in children. It is very apt to follow acute gonorrheal arthritis and those varieties of suppurative arthritis which are due to metastasis or to direct extension from neighboring foci in the ear, mastoid, etc.

The diagnosis of the existence of an ankylosis is much easier than that of its cause. The cause of an acquired ankylosis can be ascertained through a careful history, an examination of the rest of the body and of the structures around the joint. A congenital ankylosis is frequently accompanied, or rather followed, by a lack of development of the lower jaw.[1]

DISEASES OF THE MOUTH.

Injuries.—Injuries of the lips and buccal cavity present no difficulty in diagnosis. It is of interest to note that wounds of the mouth are covered with a grayish-white deposit within twenty-four hours, which to those unaccustomed to see it causes them to believe it to be the pseudo-membrane of diphtheria.

STOMATITIS.

There are two principal forms of inflammation of the buccal mucosa, viz., an ulcerative or catarrhal and gangrenous. In *gangrenous stomatitis* or *noma* there is a history of some recent infectious disease, such as measles, or the patient is quite cachectic. In its earliest stages there is a blister, usually on the inner side of the cheek, which soon becomes gangrenous. The area begins to spread along the mucosa and in the

[1] Orlow: "Deutsche Zeitschrift für Chirurgie," Bd. lx.

depth of the cheek, so that it penetrates the cheek. The gangrene is accompanied by a markedly fetid breath and the symptoms of general sepsis.

Ulcerative stomatitis is characterized by greatly swollen, reddened, readily bleeding gums, accompanied by salivation. Particles of food and detritus collect at the junction of the gums and teeth, and there is great fetor. Ulcers often appear on the inner side of the lips and cheeks and along the borders of the tongue. They are flat and could only be confused with mucous patches of secondary syphilis. The latter are, however, not accompanied by fetor, swollen bleeding gums, and salivation unless there is an accompanying mercurial stomatitis. Even then the distinction can be made by an examination of the remainder of the body for other evidences of syphilis, and the fact that the mucous patches are seldom ulcerated, are fewer in number, and seldom occur on the gums or inner side of the cheeks, but most often on the edges of the tongue.

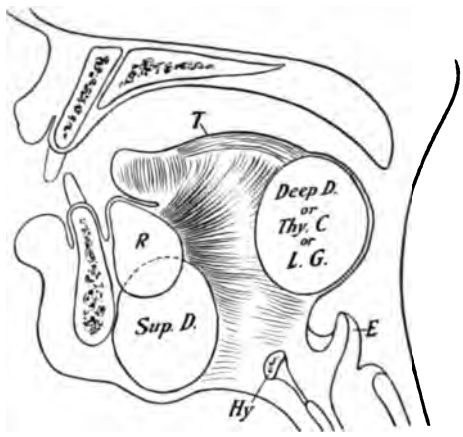

FIG. 84.—LOCATION OF VARIOUS CYSTS IN RELATION TO TONGUE AND FLOOR OF MOUTH.

R, Ranula; *Deep D. or Thy. C. or L. G.*, location of deep dermoids, of thyroglossal cysts and of lingual goiter at base of tongue; *Sup. D.*, location of superficial dermoids at floor of mouth causing bulging of submental region; *T*, dorsum of tongue; *Hy*, hyoid bone; *E*, epiglottis.

In scurvy the gums are swollen and bleed readily, and there are apt to be subperiosteal hemorrhages causing tenderness over the long bones and hemorrhages into the joints causing swelling of the latter.

SYPHILIS.

Tertiary syphilis in the form of ulcerating gummata occasionally affects the inner side of the cheek and may cause perforation. The favorite seat of syphilitic perforations, however, is at the junction of the hard and soft palates, where it causes deep ulceration and perforation of the palate. Tertiary syphilis can be distinguished from carcinoma by the absence of enlarged lymph-nodes and the lack of induration in syphilis and the presence of evidences of the disease in its tertiary form elsewhere.

THE DIAGNOSIS OF CONDITIONS AT THE FLOOR OF THE MOUTH.

A differential diagnosis must at times be made of conditions which occur at the floor of the mouth. These are (Fig. 84):

1. Inflammatory conditions:
   - (*a*) Angina Ludovici.
   - (*b*) Salivary calculus.
   - (*c*) Acute ranula.
2. Tumors:
   - (*a*) Of the submaxillary salivary gland.
   - (*b*) Chronic ranula.
   - (*c*) Dermoids.
   - (*d*) Thyroglossal cysts.
   - (*e*) Carcinoma of the floor of the mouth.
   - (*f*) Lipoma.

Angina Ludovici.—This occurs either as a complication of scarlatina or of a tooth or tongue infection. It causes a tense brawny infiltration of the floor of the mouth, pushing the tongue upward and causing difficulty in swallowing, in speech, and in breathing. It is accompanied by the evidences of severe systemic infection (fever, leukocytosis, etc.) and the skin of the neck soon becomes indurated and of a dark red hue.

Salivary Calculus.—This may occur without inflammatory reaction or ulceration and is easy to feel when the finger is pressed along the floor of the mouth or a probe is passed along Wharton's duct. If the calculus be surrounded by connective tissue, it may be quite hard and resemble a carcinoma, especially if the tissues around the calculus be ulcerated and the ulcer be surrounded by exuberent granulations. A differential diagnosis can usually be made by the use of a probe passed through the buccal opening of Wharton's duct, on either side of the frenum of the tongue close to the floor of the mouth, and encountering the calculus, or by palpating it on the floor of the mouth.

Acute Ranula.—The patient gives the characteristic history of recurrent swellings which appear very suddenly, especially while eating. The swelling is usually most marked just below the angle of the jaw and pushes up the floor of the mouth. It may attain the size of a fist and subside as rapidly as it appeared. It is due to the occlusion of Wharton's or the sublingual ducts, so that the saliva collects within the glands. The history is sufficiently typical to make a diagnosis even during the interval.

Solid Tumors of the Submaxillary Salivary Gland.—[redacted]are either chondromata or endotheliomata. They protrude b[redacted]w

(Fig. 126) and bulge in the floor of the mouth. A diagnosis can be readily made by the firm consistency of the tumor and the fact that its major portion lies in the normal position of the submaxillary salivary gland on the inner side of the jaw, close to the angle of the jaw.

Chronic or Ordinary Ranula.—As a rule, this tumor is unilateral (Fig. 85). It pushes the tongue upward and appears as a translucent tumor varying in size from a pea to an egg in the floor of the mouth. It has its origin in the cystic dilatation of the sublingual gland and is a retention-cyst. Its fluid contents are like the white of an egg.

FIG. 85.—CHRONIC RANULA.
Note the prominent tumor on right side of floor of the mouth, pushing the tongue upward.

It can be differentiated from a lipoma of the floor of the mouth by the yellowish color, the lobulated structure, and firmer consistency of the lipoma.

From a dermoid of the sublingual variety (Fig. 84) it can be distinguished by the fact that a dermoid is doughy, is not translucent, has thicker walls, is attached to the lower jaw or hyoid, and lies deeper. A cystic dilatation of Wharton's duct or chronic ranula causes a cylindric translucent swelling and is accompanied by some enlargement of the submaxillary salivary gland.

Dermoid Cysts.—These occur at the floor of the mouth and have as their chief characteristic a doughy consistency, so that they pit on pressure. They are of a yellowish color, are softer than a calculus, and occur between the fifteenth and twenty-fifth year. They are situated deeper than a ranula (Fig. 84) and cause more bulging of the submental region.

Thyroglossal Cysts.—These are softer than dermoid cysts and push the tongue up and back, causing difficulty in speech, in swallowing, and in breathing. They appear externally between the hyoid and the

lower jaw in the median line. Their deeper situation, absence of translucency, and the fact that they occur in the median line serves to distinguish them from a ranula.

Carcinoma of the Floor of the Mouth.—This condition may occur as a primary one and be situated in a fold of mucous membrane, so that attention is only called to its presence by pain. Upon lifting the tongue up, or pushing it to one side, one can detect an ulceration with dirty floor and indurated base and edges. The only condition likely to be confounded with it is a gumma. In the latter there are no enlarged submental or submaxillary lymph-nodes, the induration is less marked, and there is either the history of or presence of syphilis elsewhere. Carcinoma of the floor of the mouth due to extension from the tongue or gums presents no diagnostic difficulties.

Lipoma at the floor of the mouth is very rare.

TUMORS OF THE INSIDE OF THE CHEEKS.

The most frequent forms of neoplasms in this situation are the vascular tumors and carcinoma. The former have been referred to previously (see page 107) as invading at times the entire thickness of the cheek, so that they present the typical picture on the inner side.

An angioma may be primary in the buccal cavity, *i. e.*, on the inner side of the cheek, on the tongue or fauces.

The hemangiomata are usually of the venous type, so that one can see the typical soft bluish swelling disappear on pressure.

The lymphangiomata, if present, form a large, soft tumor of the entire cheek, congenital in origin, and growing at times to an enormous size.

Carcinoma of the inner side of the cheek is usually an extension from the jaws or lips. Only twelve cases of primary carcinoma of the cheek have been recorded. They occur close to the lower jaw and may penetrate the cheek. Their induration, raised, everted, hard edges, and tendency to early ulceration, with enlargement of the regional lymph-nodes, are so characteristic that the diagnosis is not difficult.

TUMORS OF THE PALATE.

The majority of these, if primary, are fibromata, and can be readily diagnosed from their position and consistency. They usually arise laterally and grow toward the median line. They are covered by periosteum and are slow in growth. They cause difficulty in swallowing and speech and must be distinguished from tumors of the upper jaw and from naso-pharyngeal polyps, which have grown toward the antrum. In the case of tumors of the jaw we have usually to deal with malignant

growths which increase in size rapidly and also cause bulging of the anterior surface of the superior maxilla. In the case of naso-pharyngeal polyps an examination of the naso-pharynx will show the origin of the primary tumor. In addition, by palpation one can feel that there is a connection between the palatal vault and the pharyngeal tumor (Fig. 86).

THE TONGUE.

Congenital Affections.—The most important congenital affection is the ordinary *tongue-tie*, which is due to an abnormal shortness of the frenum linguæ. This can be recognized in infancy by inability to protrude the tongue as far forward as normal. The organ can seldom be protruded further than the teeth. The condition may interfere with nursing and later with speech. The tongue is bound down to the floor of the mouth and the shortened frenum can be easily demonstrated by lifting the tongue up with a grooved director.

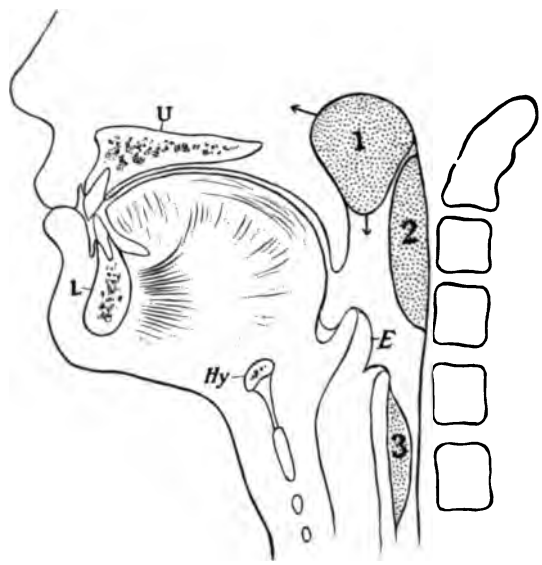

FIG. 86.—VARIOUS LOCATIONS OF PHARYNGEAL AND ESOPHAGEAL TUMORS.

U, Upper jaw; *L* lower jaw; *Hy*, hyoid bone; *E*, epiglottis; 1, naso-pharyngeal growths; the arrows point in the direction of their most frequent extension toward the nose and pterygo-maxillary fossa and downward toward the mouth; 2, location of retropharyngeal growths; 3, location of carcinomata at the junction of anterior wall of pharynx and beginning of esophagus.

Injuries of the Tongue.—The most frequent injuries of the tongue are punctured or lacerated wounds. These are either due to foreign bodies, which penetrate the tongue during eating, or the wounds are received during a fall, the tongue being caught between the upper and lower teeth. At times the wounds are so extensive as to almost completely sever the tip of the tongue. Foreign bodies may be retained in the tongue and cause a circumscribed abscess, which can be recognized by a swelling which is usually unilateral, by tenderness, and by a sense of fluctuation.

Dental or Decubital Ulcers.—These may follow the constant irritation of a sharp tooth and cause severe pain. Such dental ulcers are usually situated opposite the canine teeth, at the edges of the tongue, and cause considerable pain. The diagnosis can be made by finding the source of irritation and the fact that the ulcer heals rapidly when its cause is corrected. The differentiation of these decubital ulcers of the tongue from carcinomatous and syphilitic ulcers will be referred to again (see page 143).

Acute Parenchymatous Glossitis.—This may follow wounds of the tongue or may occur as a complication of the acute infectious diseases. The condition occasionally results in an abscess of the tongue or may be the starting-point of an infection of the cellular tissue of the floor of the mouth and neck called angina Ludovici.

FIG. 87.—PSORIASIS LINGUÆ (Hutchinson).
Notice the silvery-white area, characteristic of this disease.

Acute glossitis can be recognized by the enormous swelling of the tongue, which causes obstruction to breathing, with resultant dyspnea. The tongue cannot be moved, feels very firm and board-like, and there is profuse salivation and severe pain. The temperature as a rule is not high. Swallowing and the taking of nourishment is greatly interfered with. The mouth is usually held open and the entire clinical picture is that of great anxiety. On account of the inability to move the tongue there is also great danger of aspiration pneumonia. This condition of acute glossitis lasts from three to five days and may be complicated by an acute edema of the glottis. This complication can be diagnosed by the marked increase in dyspnea, cyanosis, and the stridor accompanying the inspiratory efforts. The only condition with which acute glossitis can be confused is an acute edema of the floor of

the mouth due to inflammation around a salivary calculus. This latter condition is more localized and seldom extends to the tongue. It is always present on the floor of the mouth and by palpation one can usually demonstrate the presence of the calculus lying in Wharton's duct.

Leukoma (leukoplakia, chronic glossitis or psoriasis linguæ).—This is a condition which is very frequent in smokers and is present on the inner side of the cheeks and lips, as well as upon the tongue. On the latter it presents itself in the form of milk-white patches of varying size. These patches of leukoplakia are distinctly white in color, especially on the dorsum (Fig. 87). On the edges and under surface of the tongue they have a little more bluish tint and are translucent. The disease may be so extensive as to cover the entire dorsum of the tongue.

The chief condition from which it must be differentiated is the mucous patch occurring in secondary syphilis. The mucous patch is of a pure white or yellowish-white color and more opaque than the leukomatous or smokers' patches. There is a greater tendency on the part of the mucous patches to extend and there is usually evidence of syphilis elsewhere, such as a secondary eruption on the body or mucous patches at the angle of the mouth or on the tonsils. Whitish patches not infrequently appear on the edges of the tongue in patients who have had syphilis, which cannot be differentiated from ordinary leukoplakia, except from the history of a previous syphilis and their greater tendency to ulcerate.

Secondary mucous patches are most often found on the edge of the tongue, while leukoplakia appears usually on the dorsum of the tongue. In leukoplakia there is no enlargement of the submaxillary lymph-nodes, whereas the mucous patches are often accompanied by this condition.

Tuberculosis of the Tongue.—This is usually present as a condition secondary to tuberculosis of the larynx, tonsils or lungs, and is oftenest found near the tip of the tongue. The ulcer is of a grayish-pink color, the floor is covered with a caseous material, and the edges are undermined and not indurated.

Tubercular ulcers are usually quite painful. They can be differentiated from syphilitic ulcers by the fact that the latter have indurated edges and there is considerable induration of the tissues around them. The ulceration is deeper and the edges are not undermined. There are no enlarged lymph-nodes and there is usually the presence or the history of syphilis elsewhere. Syphilis affects the middle, while tuberculosis is more often found on the lateral portions of the tongue. Syphilitic ulcers are painless.

Tuberculosis of the tongue can be differentiated from carcinoma

of the tongue of the ulcerative type by the facts (*a*) that the induration in carcinoma is very marked; (*b*) that the ulcer itself is not painful in the early stages; (*c*) that there are no evidences of tuberculosis in the lungs or elsewhere, and (*d*) the carcinomatous condition is accompanied by early enlargement of the submaxillary or deep cervical lymph-nodes. The age also will assist in the diagnosis, carcinoma occurring as a general rule at a later age than the average case of tuberculosis.

Syphilis of the Tongue.—This may appear (*a*) in the form of a primary chancre; (*b*) in the form of secondary mucous patches, which may or may not have broken down to form ulcers; (*c*) in the form of gummata, which may be superficial or deep, and (*d*) as a syphilitic atrophy of the base of the tongue.

FIG 88.—CHANCRE OF LEFT EDGE OF TONGUE, WITH SECONDARY ENLARGEMENT OF SUBMAXILLARY LYMPH-NODES TO WHICH THE WHITE ARROW POINTS.

Chancre of the tongue is a comparatively rare lesion. It is usually present on the upper surface or anterior edge. It shows a slight central depression, with its floor covered with necrotic tissue, and has moderately indurated edges. There is usually quite early enlargement of the submaxillary lymph-nodes (Fig. 88). The diagnosis can be confirmed within a comparatively brief period by the appearance of secondary symptoms. The principal condition which must be differentiated from a primary syphilitic lesion of the tongue is a decubital or dental ulcer, which may also be present along the edges of the tongue. This dental ulcer is not accompanied by any enlargement of the lymph-nodes, and one can usually find the source of the ulcer in the form of a sharp tooth. The ulcer heals as quickly as the source of irritation is removed.

Secondary syphilitic lesions or mucous patches occur along the borders and the under surface of the tongue. They may occur simply as

FIG. 89.—CARCINOMA OF MIDDLE OF LEFT EDGE OF TONGUE DEVELOPING UPON A GUMMA. Anterior view.

pure white, small, slightly raised areas, which are quite opaque, or as minute ulcers. They are usually quite painful and often fissured. A condition from which they must be differentiated is the small, painful, so-called aphthous ulcer associated with disturbances of digestion. These aphthous patches are usually oval in outline, seldom multiple, as is the case with mucous patches, and much more painful. The absence of the history of syphilis and of evidences of the disease elsewhere, as well as the fact that the condition heals within a few days after regulation of the diet, will serve to exclude this condition.

Tertiary Syphilitic Lesions of the Tongue.—These occur about five to fifteen years after the primary infection and are usually multiple. They may occur as gummatous infiltrations seated deeply in the substance of the tongue, which ulcerate later, or as superficial gummata. They are most

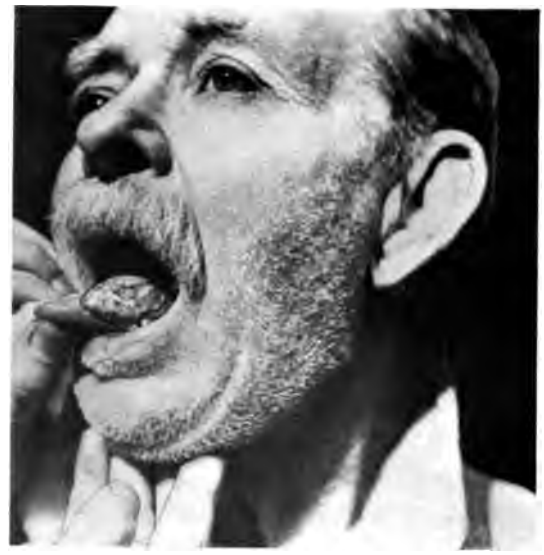

FIG. 90.—LATERAL VIEW OF A CARCINOMA OF THE LEFT EDGE OF THE TONGUE.
Same patient as shown in Fig. 89.

frequently present on the dorsum of the tongue, but may also develop, rarely, along the edge of the tongue. An ulcer, due to a broken-down gumma, has only a moderate amount of induration. The edges are not much above the level of the surrounding tissue and the floor of the ulcer is necrotic. The edges are not everted, like those of an epithelioma, and are quite steep or straight. There is no enlargement of the regional lymph-nodes, viz., the submental, submaxillary, and deep cervical.

The differentiation from a dental or decubital ulcer can be readily made by ascertaining the source of irritation and by the fact that the induration in decubital ulcer is seldom as well marked as in either a syphilitic or a carcinomatous ulcer.

In case of any doubt, the removal of the cause of the irritation and the administration of iodid of potassium for a period of one week will clear up the diagnosis.

In addition to this therapeutic test, one can usually obtain a history of or evidences of syphilis elsewhere.

Tertiary syphilis may occur in the form of fissures at the edges of the tongue, which are quite painful, and can only be discovered by separating the furred epithelium of the tongue. Syphilis is the most frequent cause of fissure of the tongue. In advanced cases, these fissures may be long and sinuous and resemble either a tubercular or carcinomatous ulcer. A carcinoma appearing in the form of a fissure has markedly indurated edges and there is always accompanying enlargement of the submaxillary and deep cervical lymph-nodes. Carcinoma may, however, develop upon a tertiary syphilitic lesion (Figs. 89 and 90) and under these circumstances a differentiation between the two at an early stage can only be made by considering the degree of induration, which is far greater in carcinoma than in syphilis, and finding enlarged, hard lymph-nodes under the chin and at the angle of the jaw.

The fourth form of syphilis of the tongue is the so-called syphilitic atrophy, which was first described by Virchow. This is always at the base of the tongue and shows itself by a smooth, shining condition, due to a loss of the epithelium of this portion of the tongue. It may appear and disappear during the course of syphilis from time to time or may persist. It may be necessary in some cases to differentiate the deep form of gummata from neoplasms of the tongue, such as carcinoma or sarcoma. Both of these are much firmer and more sharply demarcated from the surrounding structures of the tongue, the gumma is inelastic, and cannot be separated from the surrounding structures. The gum-

mata often occur multiple, while carcinoma and benign tumors are almost always single.

The differentiation of tertiary syphilitic lesions from carcinoma will be referred to later.

NON-MALIGNANT TUMORS OF THE TONGUE.

These are lipoma, hemangioma, lymphangioma, and papilloma. The **lipoma** occurs late in life, near the tip or on the dorsum of the tongue. It is very slow in growth, and can readily be recognized by the fact that the mucosa is stretched over the tumor, and through it one can see the lemon-yellow fat. There is also distinct lobulation.

Hemangiomata may occur in the capillary form as deep red nodules, the size of a pea, either single or multiple, on the dorsum or edges of the tongue. They present the same characteristics as this form of tumor elsewhere, namely, that the tumor itself can be caused to disappear by pressure but speedily returns as soon as it is relieved.

The other form of hemangioma, which occurs on the tongue, is the soft palate and cheek. It may involve only a small area, or an entire half of the tongue, causing considerable swelling, which can be greatly decreased by pressure but rapidly refills.

Lymphangioma.—Lymphangioma may occur in the capillary or cavernous forms (Figs. 91 and 92). The former can be recognized by the minute vesicles or rarely larger cysts which are present along the edges and dorsum of the tongue. The vesicles are translucent and about the size of a millet seed. The cavernous form causes a condition known as macroglossia. It is usually congenital, or develops in early infancy (Fig. 91), and is not infrequently accompanied by the capillary form. It may cause such an enlargement of the tongue that it cannot be withdrawn into the mouth but constantly protrudes through the lips. It causes disturbances in the development of the lips, jaws, and teeth through pressure.

One of the characteristics of this form of neoplasm is the fact that it is subject to recurrent attacks of inflammation, which are accompanied by great swelling and pain in the affected portion. If the condition is circumscribed, it may resemble a sarcoma of the tongue, but it can be readily differentiated by the history of its having been present since birth and the fact that its growth is far slower than that of a sarcoma.

Papilloma of the tongue occurs in the form of soft, pedunculated tumors which can be readily diagnosed.

FIG. 91.

FIG. 92.

FIGS. 91 AND 92.—LATERAL AND ANTERIOR VIEWS OF A CASE OF MACROGLOSSIA, DUE TO LYMPHANGIOMA INVOLVING BOTH THE SUPERFICIAL AND DEEP LYMPH VESSELS OF THE TONGUE IN A BOY OF FIVE.

The clear vesicular spaces correspond to the dilated superficial lymph vessels. The general enlargement of the tongue is caused by the involvement of the deeper lymph vessels. The whitish patches are the result of a hyperplasia of the epithelium of the tongue (keratosis).

MALIGNANT TUMORS OF THE TONGUE.

Sarcoma.—Sarcoma of the tongue is quite rare. It has only been found in young girls and women. It grows rapidly and ulcerates at quite an early stage. It must be differentiated from gumma and from carcinoma of the tongue. This can be done by remembering the fact that gumma is usually multiple, even though it be present in the form of a nodular growth within the substance of the tongue. Gummata occur at a later period of life and there is usually a history of syphilis or the evidences of the disease elsewhere. The growth is far less rapid than is that of a sarcoma.

From carcinoma a sarcoma of the tongue can be differentiated by the fact that the induration is much harder in a carcinoma than in sarcoma and that the former appears at a later period in life.

Carcinoma of the Tongue.—This may appear in one of four forms:

(*a*) As a fissure, with indurated edges; (*b*) as a carcinomatous ulcer; (*c*) as a warty growth whose base has become indurated, and (*d*) as a hard nodule in the substance of the tongue.

FIG. 93.—PAPILLARY FORM OF CARCINOMA OF TONGUE DEVELOPING ON PSORIASIS LINGUÆ (Jonathan Hutchinson).

Usually one does not see carcinoma in the nodular form. Ordinarily it appears as an ulcer or fissure.

According to Butlin, the most important precancerous condition is the papilloma, which precedes the development of carcinoma. The warts enlarge in size, the base becomes harder, and sooner or later ulceration occurs. Not infrequently the warts are present (Fig. 93) upon a tongue which is the seat of an extensive leukoplakia.

The least frequent form of carcinoma of the tongue is the nodule in its substance. It must be differentiated from sarcoma or gumma in the

substance of the tongue before it begins to ulcerate. This has been referred to above, under the head of sarcoma of the tongue.

The characteristics of carcinoma of the tongue, after ulceration has once begun, are:

(*a*) It appears most frequently along the edges or under surface of the tongue, (*b*) there is early enlargement of the submaxillary and deep cervical lymph-nodes; (*c*) the edges of the ulcer are everted and very firm, and (*d*) the floor of the ulcer is covered with a large amount of necrotic epithelium.

There is usually severe pain, which radiates to the ear, and this is one of the most frequent early symptoms. In the later stages the carcinomatous ulcer has a very fetid odor, is very painful, and severe hemorrhages may occur.

Carcinoma of the tongue must be differentiated from the following conditions:

(*a*) *Dental or Decubital Ulcers.*—These are present along the edges of the tongue opposite a sharp tooth. The ulcer is never as deep as that of a carcinoma, nor are the edges as indurated, and there is no enlargement of the submaxillary or deep cervical lymph-nodes. The ulcer heals in a few days if the tooth is either extracted or the sharp edge filed down.

(*b*) *From Tuberculous Ulcers.*—These never show the induration which characterizes the carcinomatous ulcer. The tuberculous ulcers are quite shallow, usually with undermined, not raised, edges, and there is no lymph-node enlargement. They occur at an earlier age and are usually secondary to tuberculosis of the larynx or lungs.

(*c*) *From syphilis* the question of differentiation arises most often in the case of gummatous ulcers. The diagnosis, as will be seen in Figs. 89 and 90, is at times exceedingly difficult. In the case shown in the illustrations, the patient gave a distinct history of syphilis and had well-marked symptoms of tabes dorsalis. The first diagnosis made in the case was that of epithelioma of the tongue, on account of the marked induration, and raised, everted edges and deep ulceration. The administration of iodid of potassium caused a marked improvement in the condition, the induration and ulceration disappearing to a great extent. In a short time, however, these signs recurred, in spite of the continued administration of the durg. When the diagnosis of epithelioma was first made, there was an accompanying enlargement of the submaxillary lymph-nodes on the side upon which the ulcer was situated, and this was thought to confirm the diagnosis of epithelioma. The final diagnosis made in this case, after removal of the tongue, was

that it had been a carcinoma of the tongue, which had developed upon a tertiary, *i. e.*, gummatous ulcer.

This case illustrates the difficulties of diagnosis between epithelioma and tertiary syphilis. According to Jonathan Hutchinson,[1] at least 30 per cent. of the patients with epithelioma give the history of previous syphilis. An accurate diagnosis can be made in the majority of cases, but in some only the microscopic examination decides.

A therapeutic test may at times be fallacious, either from the fact that carcinoma may improve after the hygiene of the mouth has been attended to, or that, as in the case illustrated in Fig. 89, the carcinoma has developed upon a gummatous ulcer.

In general, the following may be taken as the chief differential points, between epitheliomatous and gummatous ulcers:

Gummatous Ulcer.	Carcinomatous Ulcer.
1. Appears usually multiple on dorsum.	1. Appears on sides of tongue and floor of mouth.
2. May occur at any age.	2. May occur as early as thirty.
3. But little if any enlargement of lymph-nodes.	3. Early and indurated enlargement of submaxillary and deep cervical lymph-nodes.
4. But little pain.	4. Considerable pain, radiating to ear.
5. Induration less marked than in carcinoma.	5. Very marked induration. Edges raised and everted.
6. Iodid of potassium causes marked improvement within a week.	6. No improvement or only slight, unless carcinoma has developed upon a gummatous ulcer.
7. Evidence of tertiary disease elsewhere.	7. No evidence of tertiary disease, unless carcinoma has developed in an individual with previous syphilis.

Carcinoma of the floor of the mouth may spread to the under surface of the tongue, so that it is at times difficult to ascertain where the disease began. There is only one condition which it may at times be necessary to differentiate, under these circumstances, and that is the ulceration due to the infection of the tissues around a salivary calculus. There is not infrequently considerable painful induration around such a calculus, with ulcer formation, the ulcer being covered with foul granulations. It can be differentiated from a true carcinoma by the fact (*a*) that the induration is never as marked as in carcinoma; *b*, by the use of a probe one can find the calculus, and *c*, as a rule there is no induration of the lymph-nodes. It is almost impossible to make a diagnosis between an unbroken gumma and the nodular form of carcinoma, which occurs in the substance of the tongue, except perhaps

[1] "Practitioner," May, 1893.

the fact that the nodular form of carcinoma is single, while the gumma is multiple. There are other signs of syphilis or the history of syphilis in the case of a gumma.

The only other conditions of the tongue which need to be mentioned are lingual goiter and lingual tonsils.

Lingual goiter (Fig. 84) is an enlargement of the upper end of the original thyroglossal duct, which has its termination close to the foramen cecum at the posterior portion of the dorsum of the tongue. Ordinarily a lingual goiter causes no symptoms, except that when it begins to grow it may cause some difficulty in swallowing. It may be as large as a walnut and yet cause no inconvenience.

The first symptom is generally an uncomfortable feeling at the base of the tongue, a fullness in the throat accompanied by a frequent desire to swallow. There is a change in the voice, which becomes thicker and nasal in quality.[1] There may be fits of coughing. Only in the case of the largest tumors is the respiration interfered with.

Later in the disease there are recurrent, profuse hemorrhages. These occur at any time, without any apparent cause, the patient being simply aware that the mouth is filled with fluid, which on expectoration proves to be blood.

The presence of the growth can only be determined by the use of the laryngoscope or the finger. The tumor is soft, reddish in color, shows no ulceration or induration, or enlarged lymph-nodes.

The diagnosis can be made from the facts (*a*) that it is soft, not indurated or ulcerated; (*b*) it is not accompanied by enlarged lymph-nodes, and (*c*) its course is a very chronic one. The cases so far reported appear to have occurred exclusively in women between the ages of fifteen and forty.

The differential diagnosis of a lingual goiter includes:

(*a*) Dermoid cysts. This is the only condition which offers any difficulty. It is generally yellow, grows rapidly, pits on pressure and is not vascular.

(*b*) Angioma is a quite common tumor at the base of the tongue and may give rise to hemorrhages. It is, however, easily reduced by pressure, refilling immediately, and is of a bluish color.

The Lingual Tonsil.—The enlargements of this group of adenoid tissue on the dorsum of the tongue, near the foramen cecum, may cause some symptoms, especially if they become inflamed or enlarged. These are pain in swallowing, aching, irritable throat, and coughing.

The diagnosis can only be made by the use of the laryngoscopic

[1] Storrs: "Annals of Surgery," 1904.

mirror. One then sees whitish follicles, swollen and filled with secretion, extending in either direction from the foramen cecum. At times one of these may suppurate and be accompanied by parenchymatous glossitis.

AFFECTIONS OF THE SALIVARY GLANDS.

Injuries.—Wounds of the submaxillary and sublingual glands are so rare that only those of the parotid will be referred to.

Injuries of the parotid gland itself not infrequently occur in connection with those of the face.

Wounds of the gland parenchyma itself are of but little consequence, since a salivary fistula rarely follows such an injury. Chief interest lies in injuries of the vessels passing through the gland and of the facial nerve, which divides within the capsule. The vessels which pass through the gland and might be injured by a penetrating wound are the temporo-maxillary (posterior facial) vein and the terminaton of the external carotid artery. The recognition of their injury does not differ from that of similar structures elsewhere.

FIG. 94.—LEFT-SIDED FACIAL PARALYSIS.

Involving all three groups of muscles supplied by the seventh cranial nerve, namely, the eye, nasal and labial groups. Note the obliteration of the naso-labial fold on the side of paralysis, the drooping of the left angle of the mouth, the inability to close the left eyelid, and loss of action of the muscles of the eyebrows.

An *injury of the facial nerve* during its passage through the parotid capsule is recognized by the paralysis of the muscles of expression (Fig. 94). The naso-labial fold upon the side of the injury is flattened, there is inability to close the eyelids and to show the teeth or to whistle.

Injuries of the parotid duct are more important than those of the gland itself. It may be wounded while (*a*) it is still in the parotid capsule, (*b*) during its passage across the masseter muscle, and (*c*) while penetrating the tissues of the cheek to open into the mouth. The

recognition of such injury is usually not difficult. Saliva is seen to escape from a wound in the cheek, especially during mastication. The diagnosis is confirmed by inserting a fine probe through the opening of Steno's duct where it opens into the mouth opposite the second upper molar tooth. The probe will pass through the opening in the duct and emerge in the cheek wound externally. One can also observe the escape of colored liquids such as methylene-blue when injected into the buccal orifice of Steno's duct.

A *salivary fistula* is rarely congenital. In the majority of cases it follows an injury to the gland or its duct or it is the result of abscess formation in the gland or in the duct with subsequent ulceration of the overlying tissues. In both cases there is an external opening, either over the glands or along the course of the duct, lined by granulations from which a watery fluid escapes.

The secretion of a duct fistula is much greater than that of a glandular one. In the duct fistulæ there is an absence of any ejection of saliva from the opening of the duct within the mouth. This is best seen when the cheek is retracted while the opening of the duct into the mouth is observed.

Salivary Calculi.—The majority of these occur in the excretory duct (Wharton's) of the submaxillary gland; less often in the gland parenchyma. They are very rare in Steno's duct. The calculi are usually the size of a pea or bean but occasionally reach that of a pigeon's or hen's egg. Salivary calculi may give rise to the following clinical pictures:

1. They may remain dormant for many years and not give rise to any symptoms.

2. They may give rise to acute attacks of salivary retention. These are recognized by the sudden appearance, usually after eating, of pain along the duct, accompanied by a marked tender enlargement over the normal situation of the gland whose duct is blocked. After a few hours there is a sudden discharge of saliva into the mouth, and the swelling and tenderness rapidly disappear. With such a history of recurrent swelling one must always pass a probe into the duct or palpate along its course for the calculus, which can usually be readily felt.

3. There may be inflammation of the tissues around the stone and resultant abscess formation. This clinical form is characterized by the appearance of great pain, tenderness, and induration along the course of one of the salivary ducts. In the case of Wharton's duct this is most marked along the floor of the mouth, while in that of Steno's duct it is best felt with the finger while palpating the inside of the cheek or

externally along the course of the duct. In the latter location, *i. e.*, Steno's duct, the first sign may be the appearance of an induration in the middle of the cheek, accompanied by redness and swelling of the skin lying over it. The diagnosis can be made from the location of the abscess and the absence of any other cause.

4. A salivary calculus may appear as an ulceration on the floor of the mouth or on the inside of the cheek. The ulcer has indurated edges and a dirty foul-smelling base. Its resemblance to carcinoma has already been referred to. The diagnosis can only be made by the use of the probe or the finger, which encounters the calculus lying at the bottom of the crater-like ulcer.

Inflammatory Affections.—These may be acute or chronic. The acute may occur (*a*) as an epidemic variety of acute inflammation of the parotid or submaxillary glands commonly called "mumps." This is fully described in the text-books on internal medicine and presents but little difficulty in diagnosis. If, however, a complication such as orchitis or oöphoritis occurs, it is of great diagnostic importance to obtain the history of a preceding acute swelling in front of the ears or below the jaw, which lasted for a week to ten days.

(*b*) The other form of acute inflammation of the salivary glands occurs as a complication of typhoid and other of the acute infectious diseases. It may also occur after laparotomies and is then given the special name of "cœliac parotitis." (See chapter on Post-operative Complications.)

These so-called acute secondary inflammations almost always involve the parotid gland. The diagnosis can be made from the appearance of severe pain at first referred to the angle of the lower jaw and later in front of the ear and greatly increased by movements of the jaw. The onset of swelling is rapid and there is marked edema and redness of the overlying skin. If suppuration occurs the skin-infiltration and redness increase and there is soon distinct fluctuation. The abscess may burst externally either through the external auditory canal or the cheek. Such a parotid suppuration may be the starting-point of a retropharyngeal and periesophageal phlegmon or the infection may spread to the skull and give rise to a fatal meningitis.

Tuberculosis of the Salivary Glands.—This is a very rare affection, especially as a primary disease. It is not infrequent as the result of an extension of a tuberculosis of the lymph-nodes contained within the parotid capsule. In either form there is moderate enlargement of the gland and fistulæ form, lined by flabby, often caseous, granulations.

Syphilis.—This form of chronic inflammatory enlargement usually occurs in the tertiary stage. The disease almost always involves the parotid, causing a soft tumor-like swelling. The diagnosis of its syphilitic nature can only be made from the history and its rapid disappearance under appropriate treatment.

Tumors of the Salivary Glands.—In attempting to make a diagnosis of the nature of an enlargement of one of the salivary glands one must bear in mind the following possibilities:

1. If the onset is sudden the enlargement is either of an acute inflammatory nature or is due to an acute retention of secretion through obstruction of the excretory duct.

2. If the onset has been slow and the increase in size gradual it may be due (*a*) to a retention-cyst, (*b*) to chronic inflammatory changes as a result of syphilis or tuberculosis, or (*c*) to a neoplasm.

Retention-cysts and neoplasms occur far more frequently in the parotid than in either the submaxillary or sublingual glands.

Retention-cysts differ from the condition described on page 150 as acute dilatation of the ducts or glands themselves due to transitory obstruction to the flow of saliva. Retention-cysts are permanent and are due to a complete and chronic obstruction of the duct. The accumulation of secretion may take place either in the duct or in the gland. In the former case (*cysts of the salivary ducts*) the condition must be thought of when an elongated sausage-shaped fluctuating tumor is found in a location corresponding to that of either Steno's or Wharton's duct.

The swelling is quite sharply demarcated and is not tender. Infection of the contents may occur with all the signs of inflammation, *e. g.*, pain, redness, etc. If such infection occur the swelling may resemble, in Steno's duct, an inflamed lymph-node in the cheek. This, however, is a very rare condition and can be readily excluded by its more superficial location and the absence of a primary focus.

Cysts of the salivary glands give rise to a visible and palpable enlargement of the gland involved, especially if the cyst is situated close to the surface. They are very rare in the parotid and submaxillary, but occur more often in the sublingual gland. In the latter the condition is known as ranula (see Fig. 85) and can be recognized by the location at the floor of the mouth, and by its fluctuation and translucency.

Tumors of the Salivary Glands.

In the *diagnosis* of a tumor of the salivary glands one must consider (*a*) the size of the growth; (*b*) the condition of its surface, whether

smooth or nodulated; (*c*) its consistency, whether fibrous, cartilaginous soft, or cystic; (*d*) its clinical history, whether it remained stationary for many years and then suddenly increased in size, whether its growth has been rapid from the time it was first noticed or whether it has remained of about the same size for a considerable period.

Tumors of the salivary glands are best divided into the following groups:

1. Those of the connective-tissue type
   - (*a*) Fibromata.
   - (*b*) Angiomata.
   - (*c*) Lipomata.
   - (*d*) Myxoma.
   - (*e*) Myoma.
   - (*f*) Lymphangioma.
   - (*g*) Sarcoma.
2. Mixed tumors.
3. Carcinomata.

1. **Connective-tissue Type:**

(*a*) ***Fibromata.***—These are very rare. They are firm, encapsulated growths which run a benign clinical course. They grow very slowly and do not tend to recur when removed.

(*b*) ***Angiomata.***—These are also very rare and usually occur in children. They greatly resemble simple hypertrophy and form irregular soft tumors.

(*c*) ***Lipomata.***—But few cases of this form of tumor have been reported and of these all occurred in the parotid. They raise the gland itself, are soft, and often lobulated. The diagnosis is seldom possible before operation.

All of the benign tumors of the connective tissue are quite rare. Many cases were formerly described as myxoma, myoma or sarcoma which were in reality mixed tumors. All varieties of sarcoma occur, from the fibrosarcoma to the small round-celled sarcoma.

2. **Mixed Tumors.**—It has been frequently observed that tumors of the salivary glands differed clinically from neoplasms of other organs, except the testis, both in their clinical and pathologic characteristics. Since the systematic study of these tumors, by Hinsberg,[1] Wilms,[2] Wood[3] and others, it has been found that the majority of tumors of the salivary glands belong to the class of mixed growths, and that pure sarcomata are com-

[1] Hinsberg: "Deutsche Zeitschr. f. Chirurgie," Vol. lxi.
[2] Wilms: "Deutsche Zeitschr. f. Chirurgie," Vol. lxix.
[3] Wood: "Annals of Surgery," Jan. and Feb., 1904.

paratively rare. Of fifty-nine cases examined by Wood, all but four belonged to the mixed tumors. They occur about twice as frequently in the parotid as in the submaxillary and usually between the ages of twenty to forty. They contain elements from both the epiblast and mesoblast in most intimate relation to each other. The stroma contains embryonic connective tissue, *i. e.*, myxomatous tissue, cartilage, bone, fat, and lymphoid tissue. There is also epithelium present in about 24 per cent. of the cases.

FIG. 95.—CHONDROSARCOMA OF PAROTID GLAND.
Note how the tumor arises in the parotid region and extends toward and below the lower jaw and its nodulated surface.

The mixed tumors of the salivary glands are found, as a rule, to be encapsulated, lobular growths, with harder and softer areas, the denser portions being due, as a rule, to the presence of cartilage or firm connective tissue. They can be divided macroscopically into three great rough groups with characteristic morphology and to a certain extent with a definite clinical course:

1. Very fibrous tumors with very little cellular structure and with but little mucous degeneration and no cartilage.

2. Very hard tumors containing large masses of cartilage and but little connective tissue or cellular parenchyma (Fig. 93).

3. Soft, very cellular growths with transparent trabeculæ of mucous tissue surrounding areas which are opaque and yellow, which on microscopic examination will be found to be dense cellular areas, the color being occasionally, though not always, due to fatty degeneration or necrosis of the cells.

The first and second forms are usually benign in their clinical course, while the third form is likely to recur locally or to pursue an exceedingly malignant course.

The skin is freely movable over the benign growths. The ear may be distorted or pressed entirely backward by a large tumor in the parotid region, especially if the growth has extensions behind the angle of the jaw and is therefore unable to expand anteriorly.

An average of the cases of mixed tumors in the literature shows that some 10 to 20 per cent. undergo changes which express themselves in a clinically malignant course, while about 30 per cent. recur after operative removal, though some of these recurrences may be checked by a second and more complete removal. The soft noncartilaginous tumors are more likely to become malignant than the more nodular cartilaginous ones.

The malignancy of these tumors can be judged to a certain extent by their slowness of growth and their physical characteristics. The hard fibrous and cartilaginous tumors are apt to be benign, while the soft cellular types are likely to prove malignant. But frequently a tumor which has remained for a long time quiescent will begin a most rapid growth, and in a few months increase in size more than during its entire previous existence. This sudden and rapid growth is accompanied by the clinical and microscopic evidences of malignancy, and the tumor spreads through the surrounding tissues, involves the skin and the salivary glands, and may form metastases.

3. **Carcinoma of the Parotid.**—These occur in people between forty and sixty years of age and are apt to be very painful. They may grow either slowly as a scirrhous form, causing considerable retraction of the skin, or as a medullary form, growing very rapidly and causing ulceration of the overlying skin. Carcinomata of the parotid are apt to be very painful and also cause early enlargement of the lymph-nodes of the neck on the corresponding side.

The medullary form of carcinoma resembles greatly that of the same form of carcinoma of the breast. It grows very rapidly and may occur at a comparatively early period, *e. g.*, at the age of forty years, and is readily recognized not only by the rapidity of the growth, but from the

early involvement of the skin. The latter is not movable over the tumor as in the other forms of parotid tumors. The scirrhus form resembles the scirrhus form of carcinoma of the breast, causing not only retraction of the skin of the parotid region but also an invasion of the skin itself in the form of a diffuse carcinomatous lymphangitis, giving rise to the same variety of board-like infiltration which occasionally occurs in carcinoma of the breast. To this latter condition the name armor-like cancer has been given (*cancer en cuirasse*).

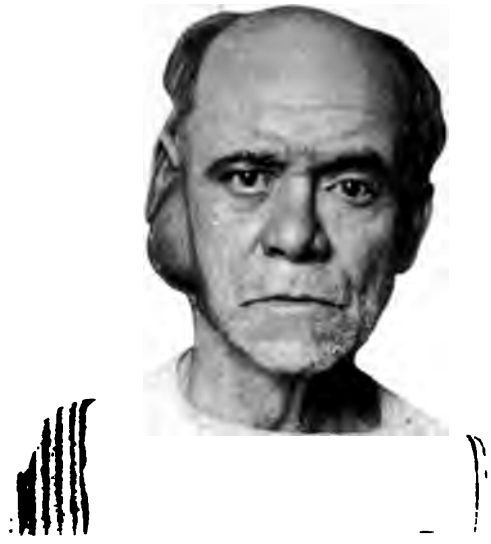

FIG. 96.—FRONT VIEW OF ENDOTHELIOMA OF PAROTID GLAND
Note typical position of tumors and upward displacement of ear. In this case the growth extended inward toward base of skull.

Diagnosis of the Tumors of the Parotid in General.—In attempting to make a diagnosis of tumor of the parotid, one must bear the different pathologic groups in mind. Tumors of the parotid cause a characteristic prominence (Fig. 97) just in front of the ear, which latter is raised away from the head. They may either grow toward the neck, forming a very prominent tumor, or toward the depth, that is, toward the pharynx. In some cases, enlargement of the

FIG. 97.—SIDE VIEW OF CAST SHOWN IN FIG. 96.
Showing displacement of ear and enlargement beneath jaw.

parotid of an inflammatory nature, such as (*a*) retention-cysts, due to salivary calculi, (*b*) of the induration described as occurring in syphilis, or (*c*) enlarged lymph-nodes lying within and upon the parotid, must be excluded.

Lymph-nodes have at times the consistency of the soft variety of mixed tumors. If they lie within the capsule and have enlarged rapidly, it may be almost impossible to make a diagnosis. If, however, they lie outside of the capsule they are movable upon the underlying parotid.

As to the variety of tumors, those belonging to the first group of mixed tumors are usually quite small, not nodular, movable within the capsule of the gland, and give the history of having been present for a long time. Those of the second group of mixed tumors contain *one-fourth* of all the tumors appearing in the parotid. They are distinctly nodulated, have the characteristic consistency of cartilage and the history of long duration, as a rule, although a rapid increase in growth may suddenly take place.

A soft tumor usually belongs to the third group of mixed tumors. These are very cellular and give the history of comparatively rapid enlargement, or, on the other hand, they remain benign for a long time and then suddenly grow. The latter is very apt to happen after an operation. This third group has the consistency of inflamed lymph-nodes more than any of the others, but the inflamed lymph-node soon becomes softer and fluctuates distinctly while the neoplasm is more apt to grow steadily in size.

Carcinomata of the parotid are exceedingly hard, occur late in life, and give the history of a steady, progressive enlargement of the gland with frequent ulceration of the overlying skin.

In the differential diagnosis of tumors of the parotid, one must not forget (*a*) lipomata lying within the capsule of the gland, (*b*) tumors of the temporo-maxillary joint, or (*c*) tumors of retropharyngeal origin growing toward the temporal fossa and pushing the parotid upward.

Cystic tumors of the parotid give rise to distinct fluctuation, are of long duration, and must always be differentiated from those varieties of mixed tumor in which much myxomatous tissue is present which may give rise to a sense of pseudo-fluctuation.

CHAPTER II.

SURGICAL AFFECTIONS OF THE NECK.

CONGENITAL AND ACQUIRED MALFORMATIONS.

Thyroglossal Fistulæ.—These are always found in the median line of the neck. The external opening is usually situated just above the hyoid bone, extending upward beneath the skin. The fistulous tract may extend through the substance of the tongue and form a cyst at the base of the tongue (Fig. 84). A fistulous opening situated in the median line of the neck should always arouse the suspicion of a patent thyroglossal duct. The only other congenital fistulæ which occur in the neck are situated along the anterior border of the sterno-cleidomastoid. These lateral fistulæ belong to the branchial variety and are referred to below. A thyroglossal fistulous tract can be demonstrated by injecting colored fluids, such as methylene-blue, through the external opening. If the tract is pervious as far as the foramen cecum at the base of the tongue, the colored fluid will escape at the latter place. Another method of demonstrating the course is to inject some bismuth solution and then take an *x*-ray picture. Both of these methods can also be employed in the diagnosis of branchial fistulæ. At times there is no external opening, but only a dilated thyroglossal duct filled with fluid. Under these

FIG. 98.—BILATERAL BRANCHIAL FISTULÆ.

EOR, External opening of branchial fistula on the right side of the neck. Note the position of the external opening near the lower end of the anterior border of the sternomastoid muscle. EOL, External opening of fistula, left side of neck. S, length of a sinus outlined in dotted lines extending to its internal opening at the level of the tonsil.

circumstances, the diagnosis can be readily made if one recalls the fact that the only other cyst which occurs in the middle of the upper part of the neck is a dermoid cyst. This is usually situated more superficially and is more often in the submental region. It is also of larger size and of firmer, more doughy, consistency than a thyroglossal cyst. The diagnosis of thyroglossal cysts at the base of the tongue was taken up on page 136.

Branchial Fistulæ.—These are usually unilateral, and the external openings are more often situated just above the sternoclavicular joint or at the middle of the sternocleidomastoid. There may, however, be openings upon both sides of the neck (Fig. 98). The internal openings are usually found on the tonsil, the lateral wall of the pharynx or on the pillars of the fauces. The fistula may be complete, having both internal and external openings, or incomplete, having only an internal or external opening, as the case may be. The incomplete internal fistulæ are lined with cylindric, and the incomplete external fistulæ with squamous epithelium. From the external opening a small amount of mucus escapes. It may close, the secretion being retained, and suppuration occur. The course of a branchial fistula can be demonstrated, as in the case of thyroglossal fistula, by injecting colored fluids or the use of bismuth, followed by a skiagraph of the neck. It can be felt at times as a firm cord through the skin, extending upward along the anterior border of the sternocleidomastoid toward the region of the tonsil. The deeper portions of a branchial fistula may dilate to form a cyst.

FIG. 99.—CERVICAL RIB OUTLINED ON SURFACE OF NECK.

The cross indicates the tip of the rib.

Carcinoma may originate from the epithelium of branchial fistulæ. Branchial cysts and branchiogenic carcinomata are discussed in the section upon tumors of the neck.

The diagnosis of branchial fistulæ may be made (*a*) from the fact that they usually occur in young individuals, (*b*) that their external opening is along the internal border of the sternocleidomastoid muscle,

and (*c*) the secretion is a thin, viscid mucus. In the absence of a suppurating lymph-node which might form a sinus here, the diagnosis is not difficult. In the case of a sinus due to tubercular lymph-nodes, the edges of the sinus are often lined by flabby caseous granulation-tissue, which will readily serve to distinguish it from a congenital fistula. At times the external opening of a branchial fistula may become temporarily closed. The retention of the secretion causes the cyst to fill. As soon as the fluid escapes the tumor disappears. Such an intermittent enlargement is not uncommon.

Cervical Rib.—Abnormal ribs attached to the transverse process of the seventh cervical vertebra, rarely of the sixth, not infrequently gives rise to symptoms calling for surgical interference, so that it is important to recognize their presence. The majority of the cases in which a diagnosis

FIG. 100.—DISSECTION OF A CASE OF CERVICAL RIB (Schultze).

7, Seventh cervical vertebra; 1, first dorsal vertebra; 2, second dorsal vertebra. On the right side observe the large cervical rib arising from the seventh cervical vertebra close to its junction with the first dorsal. On the left side observe a shorter cervical rib.

has been made during life have occurred in adults. The bony outgrowth is usually bilateral and can be palpated as a firm, bony tumor just above the inner end of the clavicles, running backward and upward toward the spine. Nearly fifty cases have been reported in which it has been recognized during life, either through producing pressure on the subclavian artery or some of the branches of the branchial plexus. When the subclavian artery passes across a cervical rib, it may occasionally give rise to a pulsating tumor simulating an aneurysm. There is an absence, however, of the expansile pulsation and bruit characteristic of aneurysms in general, and a cervical rib producing such abnormal pulsation of the subclavian artery occurs at an earlier period of life than do non-traumatic aneurysms. A skiagraph will confirm the suspicion that the pulsating tumor is simply the subclavian artery stretched over the end of a cervical rib.

The effects on the arteries vary from weakness of the radial pulse to pallor and coldness of the hand. In extreme cases there is thrombosis of the peripheral vessels, resulting in gangrene. The nerve-pressure symptoms vary from neuralgic pain, situated in one of the branches of the brachial plexus, simulating at times a neuritis, to paresthesias and pareses of the muscles of the arm.

The diagnosis can be made by (*a*) the palpation of the bony tumor in the neck, (*b*) by disturbances of circulation, and (*c*) pressure symptoms upon the brachial plexus. The cervical rib may vary from

FIG. 101.—X-RAY OF A CASE OF CERVICAL RIB
The rib itself has been outlined in black.

a short projection an inch long to one extending to the first rib. It must be differentiated chiefly from exostoses of the spine, which are very rare. These cause less pressure on the subclavian artery, but more on the vein, causing edema of the arm. The condition must also be differentiated from tuberculous lymph-nodes in the posterior triangle of the neck. These nodes are never as hard as the cervical rib, nor are they ever attached to the spine. Similar nodes are also to be found in the upper portions of the neck. A third condition from which a cervical rib must be differentiated is that of carcinomatous enlargement of the supraclavicular lymph-nodes, causing pressure on the surrounding structures. These

may be very firm in consistency, but are never as hard as a cervical rib, and there is usually a history of a primary growth or it is found at the time of examination, in the territory drained by these nodes (Fig. 105).

Wry-neck, or Caput Obstipum.—Wry-neck produces a deformity which can be readily recognized by the fact that the head is inclined (Fig. 102) toward the side of the affected muscles, while the chin is directed toward the opposite side, and there is always some rotation of the head toward the opposite side. The chief point of surgical interest is to determine (*a*) whether the condition is of acute or chronic nature, or (*b*) whether it is symptomatic or congenital in origin. Of the acute causes which may produce it, the most frequent is muscular rheumatism. This acute rheumatic form can be recognized by its sudden appearance, the absence of any swelling or tenderness along the muscle, considerable pain on movement, and the history of the condition having appeared quite acutely. It usually disappears rapidly after antirheumatic treatment. A second variety of acute wry-neck is that accompanying infection of the deep cervical lymph-nodes (Fig. 102). This form is always accompanied by a swelling lying along the anterior or posterior borders of the muscle and there is considerable pain upon movement. The neck is held quite rigid in the typical wry-neck position. Unless this swelling be correctly interpreted as due to infection, the rigid position of the neck with rotation of the head, etc., may cause the suppuration to be overlooked. A third or symptomatic wry-neck posture is at times assumed by patients following operations for extirpation of tuberculous lymph-nodes, and may continue for some months. A fourth variety of wry-neck is that following extensive burns or other cicatricial processes of the neck. It is often called the dermatogenous form, to distinguish it from the simple or rheumatic, and

FIG. 102.—TYPICAL WRY-NECK POSITION.
Occurring as the result of suppuration of the deep cervical lymph-nodes.

the symptomatic forms just referred to. There is no difficulty in distinguishing this form, owing to the fact that there is always ample evidence of scar tissue, either on the surface or in the subcutaneous structures. A fifth form is that which occurs in children, the myogenic. It is due to rupture of and hematoma formation in the sternocleidomastoid muscle, and is known as the congenital form. Congenital wry-neck is often accompanied by a scoliosis of the cervical vertebræ, the convexity in the cervical region being toward the side opposite to that upon which the wry-neck is situated. It is not infrequently associated with limitation of the visual field and facial hemiatrophy. A sixth form of wry-neck is that due to disease of the cervical vertebræ. In this there are neuralgic pains radiating from one or both sides of the vertebræ. There is also pain over the spine, stiffness, and the head is held in the typical fixed position.

Wry-neck may also occur in a seventh form secondary to subluxation and rotation of the cervical vertebræ. These cases always have a history of trauma and the spine is held rigid without any of the pain characteristic of tubercular processes, and the *x*-ray may at times confirm the subluxation.

An eighth form of wry-neck which may at times call for surgical interference is that in which there is a frequently recurring spasm of the sternocleidomastoid and trapezius muscles. This form is called spasmodic wry-neck.

INJURIES OF THE NECK.

Injuries of the various structures of the neck may occur as the result of suicidal attempts, of gunshot or stab wounds, or of fractures. The injuries to the veins, arteries, nerves, and thoracic duct occurring as the result of operation do not differ from those due to other modes of injury and will not be considered separately.

Injuries to the Arteries.—These occur most often as the result of stab or gunshot wounds and may result in a partial or complete severing of the artery or in the formation of an aneurysm. The result of injury of the arteries of the neck is either (*a*) immediate death, if the wound in the artery communicates with the wound in the skin, or (*b*) a large swelling forms in the neck in the immediate vicinity of the wounded artery, due to the escape of blood into the cellular tissue. (*c*) Death may occur at a later period through sloughing of the wall of an artery following a small wound of its wall, with resultant secondary hemorrhage. (*d*) The formation of a traumatic aneurysm.

The diagnosis of injury of the carotid artery or its two main branches

may be made from the escape of bright red blood in large quantities through the external wound or the formation of a hematoma beneath the skin. There is no temporal pulse to be felt upon the injured side. In wounds of the subclavian arteries the same symptoms of excessive primary hemorrhage or the formation of a hematoma may be present, accompanied by the absence of the radial pulse of the same side.

The majority of cases of wounds of the arteries of the neck are not seen immediately, so that the diagnosis depends upon the location (*a*) of the subcutaneous hematoma, (*b*) the location of the wound, and (*c*) the fact that there is no pulse in the distal arteries or the position of the aneurysm.

The vertebral artery is sometimes injured in gunshot wounds passing through the mouth or through a wound entering an inch below and behind the mastoid. At times the symptoms of injury of an artery may have been so slight at the time of the accident that the swelling, if any was present, is overlooked, and the patient only presents himself when a pulsating tumor has appeared as the result of the formation of a traumatic aneurysm.

Traumatic Aneurysms.—The symptoms of both traumatic and spontaneous aneurysms of the neck are the same. In the former there is, however, the history of an injury, usually a gunshot or stab wound. The aneurysm may involve the artery alone or there may be communication between the artery and the vein. The majority of traumatic aneurysms of the neck are found in the common or external carotid arteries.

The diagnosis can be made by finding a pulsating tumor, usually situated close to the bifurcation of the common carotid artery, in which a thrill is to be felt. If the aneurysmal tumor is grasped between the index finger and thumb, one can feel a distinct expansile pulsation. Not infrequently the diagnosis is aided by finding symptoms (*a*) of compression of the trachea, causing more or less dyspnea, (*b*) of the esophagus, causing difficulty in swallowing, and of (*c*) pressure upon the hypoglossal or recurrent laryngeal nerves, causing difficulty in speech and hoarseness, respectively. There may also be symptoms of pressure upon the nerves of the brachial plexus. In aneurysm of the external carotid, the tumor is situated below the angle of the jaw and pushes the tonsil inward. At this point an aneurysm may be simulated by a lymph-node lying upon the external carotid. In the latter case the pulsation is only marked when the gland is pressed against the vessel and there is no expansile pulsation, as is the case in true aneurysm.

Aneurysms of the subclavian artery may follow gunshot or stab wounds or rarely fractures of the clavicle, in which the fragments have

penetrated the artery. Most often, however, aneurysms of this vessel are the result of endarteritis. Aneurysms of the first part of the subclavian artery are difficult to distinguish from those of the common carotid and innominate arteries, if on the right side. Aneurysms of the third part of the subclavian can be recognized by the presence of a pulsating tumor just above the clavicle, with the thrill, expansile pulsation and bruit so characteristic of aneurysms elsewhere.

An aneurysm of the subclavian artery must be differentiated from the condition referred to on page 161, viz., the subclavian artery stretched across a cervical rib and giving rise to a pulsating swelling, which may resemble an aneurysm. The absence of expansile pulsation and the detection of the elongated cervical rib serve to distinguish it from a true aneurysm. Subclavian aneurysms may also be distinguished by the fact that they are much more apt to give rise to symptoms of pressure on the nerves of the brachial plexus, causing either neuralgia or weakness of the affected muscles. The most frequent location of aneurysms of the subclavian is in the third portion of the artery, situated on the outer side of the sternocleidomastoid muscle.

Arterio-venous aneurysms as the result of trauma most frequently involve the common carotid artery and internal jugular vein. The tumor is usually irregular and firm, and it may be diminished but not entirely obliterated by pressure. There is an intense murmur and very marked thrill present, both of which disappear when the carotid is compressed just above the clavicle.

Injuries of the Veins.—Injuries of the deeper veins, such as the innominate and subclavian, are most frequently the result of gunshot or stab wounds. Those of the internal jugular and of the superficial veins of the neck, which pass across the median line, are usually the result of attempts at suicide.

The diagnosis of an injury of a vein may be made in the same manner as in the case of injury of an artery. In the case of wounds of a larger vein such severe hemorrhage usually occurs as to cause immediate death. A subcutaneous hematoma may form around the wound in the vein, and in a few cases the patient is seen in this condition.

In wounds of the smaller veins, especially during operations, *air embolism* may be the result. This condition is recognized from the presence of one of two groups of symptoms, either (*a*) a hissing sound in the neighborhood of the wound, followed by immediate death, or (*b*) the onset of marked dyspnea, great anxiety, rapid and weak pulse, sudden pleuritic pain and signs of a pulmonary infarct.

Wounds of the veins may be recognized, as was just mentioned,

either by primary symptoms, such as the escape of blood externally, the position of the wound, and the history of a gunshot or stab wound or an attempt at suicide, or it may be recognized by the formation of a hematoma or the presence of symptoms of air embolism. The secondary effect of a wound of the veins is the formation of an arterio-venous aneurysm, if the wound in the vein communicates with that of the artery.

Another rare result of injury to the vein is a secondary hemorrhage occurring from erosion of the vein.

Injuries of the Nerves of the Neck.—*Injuries of the vagus* may occur as the result of gunshot or stab wounds or rarely following operations. Injury of the vagus of one side is attended by hoarseness. The injury of both vagi is rapidly fatal.

Injuries of the sympathetic cause dilation of the pupil on the side of the injury if above the superior ganglion.

Injuries of the phrenic cause paralysis of the corresponding half of the diaphragm. *Injuries of the brachial* plexus may occur as the result of violent blows, of fractures of the clavicle, after gunshot wounds, or as the result of severe traction on the shoulders during birth. This last-named form may appear in children under the clinical picture of the Duchenne form of paralysis (Fig. 318). In this condition there has been laceration of the lowermost branches of the brachial plexus.

A diagnosis of injuries of the brachial plexus may be made from the appearance of trophic disturbances, of paralyses with or without painful contractures, or of neuralgias of some of the branches of the plexus, following the injuries just referred to.

Injury of the hypoglossal nerve, if unilateral, causes a temporary disturbance in speech, but this is usually compensated. Bilateral injury is fatal on account of the resultant aspiration pneumonia.

Injuries of the cervical nerves are very rare and usually cause only loss of sensation, transitory in nature, of the skin of the neck.

Injury of the spinal accessory nerve often occurs as the result of operations for the removal of tuberculous lymph-nodes in the posterior triangle of the neck. It may be recognized by the inability of the patient to raise the shoulder on the side of the injury (Fig. 11).

Injuries of the Thoracic Duct.—This most often follows extirpation of tumors or of lymph-nodes in the posterior triangle of the neck. It may be recognized by the escape of a thin, milky fluid of sweet odor from the wound, and may involve either the main duct itself or one of its branches. If it has persisted for some time, it causes considerable emaciation and weakness, due to the non-absorption of fat. In addition to the rapid and progressive emaciation, there is marked lassitude, pallor,

thirst, scanty urine. Death occurred in five of forty cases collected by Stuart.[1]

Fractures of the Hyoid Bone.—These occur after attempts at strangulation or after being run over. It may be diagnosed by the presence of swelling over the hyoid, by severe pain referred to the same region, and from the dyspnea. Not infrequently there is also great difficulty in speech and in swallowing. Hemorrhage accompanying coughing spells is also a frequent symptom.

Fractures of the Larynx.—These occur as the result of choking, of gunshot wounds, and of attempts at suicide. On palpation one can find a deformity due to a dislocation of the cartilages of the larynx and also crepitus. There is often severe cough with bloody expectoration and other symptoms referred to under fractures of the hyoid bone. One can distinguish it from a fracture of the hyoid, however, by the greater cyanosis and dyspnea. One can often feel the ends of the bone projecting through the overlying skin.

Fractures of the Trachea.—These are comparatively rare. They are the result of stab or gunshot wounds or attempts at suicide. They may be recognized by the presence of symptoms of stenosis of the air passages, such as stridor, dyspnea, asphyxia, and hoarseness. Not infrequently there is emphysema of the subcutaneous tissues. In wounds of the trachea following cut-throat, there is often suppuration of the surrounding tissue and secondary hemorrhage. The infection may spread to the mediastinum. When the external wound is large, the diagnosis of an injury of the trachea is easy. When it is small, one can only suspect it from the presence of subcutaneous emphysema and bloody expectoration. If the wound in the trachea communicates with a wound in the esophagus, food escapes through the wound in the trachea and is expectorated by the patient.

Cut-throat.—The various conditions found in cases of cut-throat or attempts at suicide have been described in detail. A diagnosis may be made by considering the symptoms of injuries of the air passages, nerves, arteries, and veins just spoken of. The internal jugular or common carotid are seldom, if ever, injured. The typical location for the wound in the skin and deep parts is at the level of and through the cricothyroid membrane. If the wound passes into the larynx, it may sever the epiglottis and open the pharynx. At this level the lingual and superior thyroid arteries and veins and superior laryngeal nerve may be injured. If the wound is above the hyoid, the lingual and facial arteries and veins may be severed, and the tongue may fall

[1] "Edinburgh Medical Journal," October, 1907.

back upon the epiglottis, causing asphyxia. If the wound is through or below the thyroid cartilage, the recurrent laryngeal may be severed, the trachea and esophagus cut across, and there may be marked asphyxia from entrance of blood into the trachea. The late complications of wounds at this latter level are cellulitis, mediastinitis, pneumonia, and fistulæ of the trachea.

FOREIGN BODIES IN THE AIR PASSAGES.

The diagnosis of foreign bodies in the larynx must be made from the history and the presence of symptoms of stenosis or irritation. These

FIG. 103.—X-RAY OF SAFETY PIN OF MEDIUM SIZE IN TRACHEA. REMOVED BY TRACHEOTOMY. The outlines of the pin have been strengthened in black.

latter are violent coughing, recurrent attacks of suffocation, cyanosis, hoarseness, or aphonia. The sputum is at first bloody and then purulent. If the foreign body is a solid one it may act as a ball-valve, being drawn downward during inspiration and pushed up during expiration. The symptoms of stenosis are in general most marked during inspiration.

Foreign Bodies in the Trachea or Bronchi.—The diagnosis depends (*a*) upon the history (one must ascertain how the foreign body entered the air passages) and (*b*) upon the presence of certain local symptoms. These latter are wheezing sounds in the bronchi, accompanied by diminished respiratory movement upon the side on which the foreign body is situated, and diminished fremitus. Often there is partial or entire collapse of the corresponding lung.

In the case of metallic substances an *x*-ray picture will often show their exact location (Fig. 103). In the case of non-metallic substances one must depend upon a search for them with the bronchoscope, an instrument devised by Killian.

INFLAMMATORY PROCESSES.

Inflammatory processes in the neck may be either acute or chronic. The majority of the latter are tuberculous or actinomycotic in nature. The tuberculous form will be taken up in connection with inflammation of the cervical lymph-nodes. Acute suppurative processes may arise in the neck in four different ways:

1. Infection of wounds of the skin or soft parts.
2. Extension from infection in the mouth, or from the arm, thorax, or spine.
3. Infection of the lymph-nodes (this is the most frequent form).
4. Metastatic (this is quite rare).

The diagnosis of acute infective processes of the neck depends upon a knowledge of the applied anatomy. This teaches that there are four places in which infection occurs, as follows:

1. In the submaxillary region. In this the submaxillary lymph-nodes lying within the pocket of deep fascia (Fig. 105) in which the submaxillary salivary gland is contained are affected, and from this focus the surrounding tissue is invaded.

2. The previsceral form. In this the tissue in front of the trachea and esophagus lying beneath the deep layer of the deep cervical fascia is involved; there is direct communication with the anterior mediastinum.

3. The connective tissue along the carotid sheath. Infection occurs most frequently here from the lymph-nodes.

1. **Infection in the Submaxillary Region** (*Angina Ludovici*).—The diagnosis of infection of the submaxillary region may be made from the presence of swelling, tense infiltration of the surrounding tissues and

tenderness. The swelling is accompanied by local and general rise in temperature and by redness. There is also dysphagia or difficulty in swallowing from pressure on the esophagus and some dyspnea in the more extensive cases of infection. The dyspnea, owing to pressure on the larynx and trachea, may even be so severe as to cause edema of the glottis or asphyxia.

The floor of the mouth is swollen and the tongue is elevated. In severe cases perforation of the arteries, rarely of the veins, or a phlebitis of the internal jugular may occur. If no surgical relief is given, suppuration may extend to the mediastinum along the previsceral or carotid sheath spaces. In ordinary cases of infection in this region the suppuration is simply confined to the lymph-nodes, but in Ludwig's angina the infection spreads diffusely.

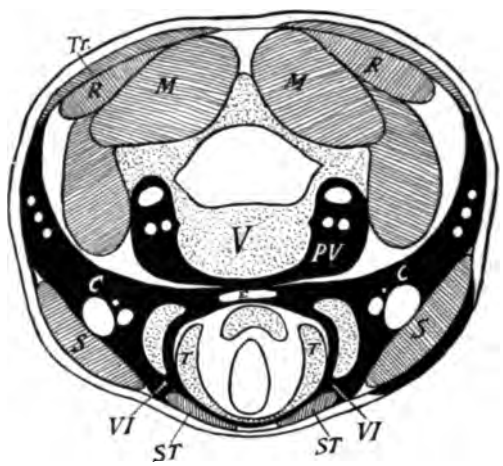

FIG. 104.—MODE OF EXTENSION OF INFECTION IN DEEP CERVICAL FASCIA.

ST, Sternothyroid and hyoid muscles; *S*, sternocleidomastoid muscle; *R* and *M*, deep muscles at back of neck; *Tr*, trapezius muscle; *V*, body of cervical vertebra; *C*, structures of carotid sheath; *E*, esophagus; *T*, thyroid cartilage, and opening of larynx; *VI*, connective tissue of free visceral space (the black shading shows direction in which pus can spread); *PV*, mode of spreading of pus in prevertebral layer.

2. **Previsceral Suppuration.**—The majority of the infections of the cellular tissue of the previsceral space (Fig. 104) arise from the thyroid gland, or as extensions from suppuration in the submaxillary or carotid sheath spaces. The diagnosis can be made from the presence of edema, usually of a tense character, of redness, pain and the ordinary signs of infection, such as temperature, and, in the severer cases, symptoms of sepsis. There is great danger of pressure on the trachea and esophagus, especially upon the former, and of extension of the suppuration to the anterior mediastinum, with which this previsceral space communicates. The presence of this extension to the mediastinal connective tissue can be recognized by the continuance of the temperature and evidences of sepsis after subsidence of the inflammatory disturbances in the previsceral space, as well as the extension of the local inflammatory signs to the

suprasternal fossa and the tissues over the sternum. This condition is referred to more fully in the chapter upon the thorax.

3. **Suppuration in the Carotid Sheath Space.**—The most frequent sources of infection of this space are the lymph-nodes lying beneath the sternocleidomastoid muscles and along its anterior and posterior borders. These suppurative inflammations of the lymph-nodes *are always secondary to a primary injective focus in the territory drained by them.* In the case of the upper internal jugular group the primary focus is usually to be found in the pharynx. It may, however, be the direct result of extension from infection of the submaxillary lymph-nodes. In the lower internal jugular group (Fig. 105) the infection may have had its origin in the skin of the supraclavicular fossa. It is well to remember, from a diagnostic standpoint, that the primary focus in every form of suppurative lymph-node infection may have entirely healed and the presence of such a primary focus be forgotten by the patient when he is examined. In the case of the infective cellular inflammations along the carotid sheath, the patient presents himself with a swelling most marked either along the anterior or posterior border of the sternocleidomastoid. If the infection is extensive a wry-neck position is assumed and there is edema of the overlying skin, dyspnea, and dysphagia. If the upper in-

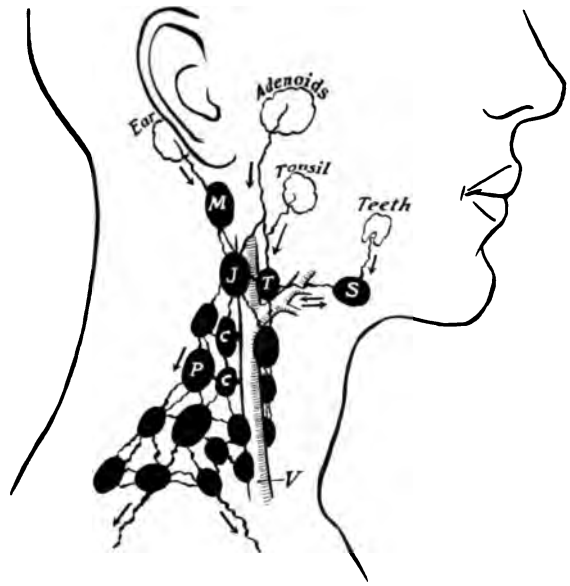

FIG. 105.—PORTALS OF INFECTION AND THE MOST FREQUENT NODES INVOLVED IN TUBERCULOSIS OF THE CERVICAL LYMPH-NODES.

The arrows show the direction of the efferent lymph-vessels leading from the various portals of infection toward the respective nodes which are first infected: *M*, Uppermost node of internal jugular vein which receives the infective material from the ear; *T*, tonsillar gland located in angle of internal jugular and anterior jugular. This receives the lymph from the tonsil. From *J* downward are to be seen the principal lymph-nodes of the neck which receive the lymph from the head and face. These are the internal jugular group lying beneath the sternocleidomastoid muscle in close relation to the internal jugular vein (*V*) and in direct connection with the lymph-nodes of the posterior triangle of the neck (*P*). *S*, Submaxillary nodes. These lie either upon or within the capsule of the submaxillary salivary gland and receive the infective material from the teeth and jaws, but may be infected by retrograde currents from the tonsillar lymph-nodes. *C*, Two nodes are shown with their short venous branch leading into the internal jugular.

ternal jugular of lymph-nodes is affected, the swelling is usually between the angle of the jaw and the sternocleidomastoid muscle. If the lower set is involved, the swelling is most marked at the posterior border of the muscle just above the clavicle. In severe cases, there are symptoms of constitutional sepsis, such as high temperature, rapid pulse, a high degree of delirium, and great prostration. In addition there may be dyspnea and difficulty in swallowing through pressure on the trachea and esophagus. If the condition is not relieved, the pus will either escape to the surface and break through the skin, or find its way to the anterior mediastinum. In diabetic patients, gangrene of the overlying skin frequently occurs.

Infection of the Superficial Structures of the Neck.

The most frequent form of superficial infection which occurs in the skin of the neck is a furuncle, which may occur at any portion, but is usually found in the region just beneath the superior curved line of the occipital bone, that is, at the nape of the neck. The area involved may be extensive, there being multiple foci of suppuration. The term carbuncle is given to this form.

The diagnosis of this condition is not difficult. The chief point to be remembered, however, is the possibility of the infection extending to the lymph-nodes along the carotid sheath or in the posterior triangle of the neck, referred to above. This infection of the lymph-nodes may be present quite early in an ordinary furuncle, as a nodular enlargement along the borders of the sternocleidomastoid muscle. This nodule will usually subside as soon as the furuncle has healed. In other cases these deep lymph-nodes begin to enlarge and suppurate two or three weeks after healing of the furuncle. The diagnosis of this complication is referred to above.

A number of other infective inflammations occur in the neck, whose recognition is of great importance.

The Woody Phlegmon, or Phlegmon Ligneux of Reclus.—This occurs either in the lateral or anterior regions of the neck. It is characterized by a very chronic course and involves a large area of skin and subcutaneous tissue. There are but few inflammatory symptoms. The skin is red and extremely hard, almost woody in consistency, hence the term woody phlegmon. Later this induration becomes softer and there is pus formation.

Actinomycosis.—The neck is more frequently affected than any other portion of the body, after the jaw and teeth. The disease usually arises by direct extension from primary foci in the jaw or teeth. It can

be recognized by the appearance of a slowly increasing, painless swelling in the submental and submaxillary regions, which is at first quite indurated, but soon softens, and the abscess breaks, leaving a sinus lined with flabby granulation-tissue, containing the characteristic yellowish granules. There is a distinct bluish color over the softer areas. The diagnosis can be made usually (*a*) from the history of the occurrence of similar abscesses around the jaw, (*b*) from the characteristic tense infiltration of the deeper connective tissue of the neck, with abscess and sinus formation. There are two conditions which must be differ-

FIG. 106.—BILATERAL ENLARGEMENT OF THE SUBMAXILLARY AND PAROTID LYMPH-NODES IN HODGKIN'S DISEASE.

FIG. 107.—SIDE VIEW OF PATIENT WITH HODGKIN'S DISEASE.

Observe the large submaxillary glandular swelling as well as the relatively large size of the nodes lying over the parotid salivary gland.

entiated from it. The first is tuberculous inflammation of the lymph-nodes, and the second, tertiary syphilitic gummata. The former can be distinguished from the fact that the area involved by actinomycosis is larger than is the case in tuberculosis.

Tuberculosis is usually limited to certain definite groups of lymph-nodes, either the submental, submaxillary, or deep cervical, which, if they break down and form sinuses, differ in their external appearance from actinomycosis. The tubercular sinuses have undermined

edges, and the granulations, although flabby, are often caseous in appearance. The finding of the actinomyces in the yellow granules of the pus will confirm the diagnosis of actinomycosis. There is often a history of cattle infected with the disease, which the patient has been taking care of. From syphilitic gummata, the differentiation is comparatively easy. These, when they give rise to ulceration of the skin, have indurated edges and the ulcer is usually extensive. The edges are sharp or steep and are not undermined. There is also a history of an initial lesion or the evidences of the disease elsewhere.

Fig. 1[illegible] Anterior View of Case of Marked Hodgkin's Disease.

Fig. 150.—View of Case of Hodgkin's Disease. Showing both cervical and axillary node enlargement.

Blastomycosis.— Localizations of this disease may occur in the neck, as elsewhere. The diagnosis depends upon finding the typical organisms.

Affections of the Lymph-nodes of the Neck.

These may be either primary or secondary, acute or chron[illegible] lymph nodes of the neck, as elsewhere in the body, act as infective agents brought to them from the territory which [illegible] If one bears this in mind, the diagnosis of affections of the ly[illegible] in any portion of the body becomes much simpler and is diagnostic aid (Fig. 105).

(*a*) Simple hyperplastic lymph-node inflammation.

(*b*) Tuberculosis of the cervical lymph-nodes:

1. The acute form.
2. The pseudo-leukemic form.
3. The chronic form.

FIG. 112.—METHOD OF EXAMINATION FOR ENLARGEMENT OF THE DEEP CERVICAL LYMPH-NODES ALONG THE BORDERS OF THE STERNOCLEIDOMASTOID MUSCLE.

Both patient and examiner should be seated, the latter sitting upon the right side of the patient, when the size and number of the nodes of the left side is to be determined and vice versâ in the case of the right side. The patient's head should be grasped with one hand, while the other hand is inserted along the anterior border of the sternomastoid, the muscles of the neck being relaxed by bringing the patient's chin down somewhat toward the sternum.

(*c*) Pseudo-leukemia or Hodgkin's disease.

(*d*) Lymphatic leukemia.

(*e*) Lymphosarcoma.

(*f*) Secondary carcinomatous lymph-nodes.

(*g*) Syphilis of the cervical lymph-nodes.

In examining any case in which by a process of exclusion of other

forms of tumors of the neck (see page 184) one has arrived at the conclusion that the enlargement is due to the lymph-nodes, the first question to be considered is, are these lymph-nodes primary or secondary in nature?

The majority of all enlargements of the lymph-nodes of the neck are secondary in nature, only a small percentage being primary. In this manner one can first exclude, in any given case, the so-called primary forms, which are as follows:

(*a*) Lymphatic leukemia.

(*b*) Lymphosarcoma.

(*c*) Pseudo-leukemia (Hodgkin's disease), or malignant lymphoma.

FIG. 113.—METHOD OF DETERMINING FLUCTUATION IN SUPPURATING LYMPH-NODES OF THE NECK.

The chief characteristics of these primary enlargements are the following:

Lymphatic Leukemia.—In this disease the enlargement of the lymph-nodes is usually quite extensive, being distributed over both sides of the neck, as well as over the axillary and inguinal regions. The glands themselves are soft and quite movable. There is no tendency to any adhesion of the individual glands to each other or to the surrounding tissue. There is also no tendency to softening, as is the case with tuberculous enlargements. The examination of the blood will show the presence of a very large number of lymphocytes, so that the proportion of white to red corpuscles, instead of being one to five hundred, is sometimes one to two. The disease may occasionally begin in a very acute manner with fever, etc. (acute lymphatic leukemia).

Lymphosarcoma.—This is really a small round-celled sarcoma, and usually begins in one lymph-node, which enlarges rapidly. The growth soon infiltrates the surrounding tissue and there is often early ulceration

of the skin over the tumor. Very early in the disease there are evidences of metastases in distant parts of the body.

The tumor is always movable on the deeper structures in the early stages, so that it can be distinguished from other forms of sarcomata arising from the deeper tissues of the neck. The diagnostic points are the rapid growth of the tumor and its firm consistency. It is much harder than a tuberculous lymph-node and has a marked tendency to ulceration.

FIG. 114.—THE RELATION OF TUBERCULOUS LYMPH-NODES OF THE NECK TO THE STERNOCLEIDOMASTOID MUSCLE.

1, Several large nodes which are fused together, lying in front of the muscle, extending as far forward as the angle of the jaw; the black area at the lower level of this mass indicates a sinus covered with tuberculous granulation-tissue; 2, a similar mass situated in the upper portion of the posterior cervical or occipital triangle, between the upper ends of the sternocleidomastoid and trapezius muscles; the sternocleidomastoid muscle usually lies superficial to such glandular masses, the latter being adherent to the deep vessels; 3, mass of nodes at lower portion of posterior cervical triangle (subclavian triangle); the black area at the center of this mass is a sinus similar to the one in relation to the other nodes; 4, outlines of sternocleidomastoid muscle.

Pseudo-leukemia, or Hodgkin's Disease.—This may occasionally appear in an acute, but more frequently in a chronic form. The nodes become enlarged at first on one side of the neck and soon afterward those of the other side are affected. This is accompanied by enlargement of the axillary and inguinal lymph-nodes, and later of the bronchial, mediastinal, and mesenteric. This form of enlargement of the lymph-nodes is progressive in character. It affects the lymph-nodes all over the body, usually more or less symmetrically. There is no tendency to suppuration although the lymph-nodes themselves are usually soft, but may be firm. They are easily movable in the surrounding tissue, and do not become adherent to the skin, which is movable over it. Often different nodes of one group become adherent to each other, forming quite large tumors, which can be recognized as lymph-nodes by their nodulated, soft consistency and their location along the usual area of distribution of

the cervical lymph-nodes. The enlargement is painless as a rule and not accompanied by temperature.

The diagnosis of this form of chronic enlargement of the cervical lymph-nodes can be made from (*a*) the symmetrical distribution of the lymph-node enlargement, (*b*) the absence of any tendency to break down, and (*c*) the progressive involvement of lymph-nodes all over the body, which later in the disease cause pressure symptoms.

The latter are: dyspnea through pressure on the trachea, or dysphagia through pressure on the esophagus. There is usually accompanying anemia and cachexia. No changes in the blood occur except a progressive anemia, thus serving to distinguish it from lymphatic leukemia. There is great difficulty in differentiating a true case of pseudo-leukemia or malignant lymphoma (Hodgkin's disease) from the pseudo-leukemic form of tuberculous lymph-nodes first described by Fischer. This is referred to on page 183.

FIG. 115.—TUBERCULOUS LYMPH-NODES OF THE NECK.

Observe the prominence just below and behind the angle of the jaw, to which the arrow points. The black area at the lower edge of the swelling and a similar area at the lower portion of the neck are two sinuses lined with yellowish granulation-tissue, characteristic of tuberculosis.

If, in a case of enlargement of the lymph-nodes of the neck, one has excluded these three primary forms of lymph-node enlargement, the diagnosis must be further made by excluding one after the other of the following secondary forms:

(*a*) Carcinomatous.

(*b*) Syphilitic.

(*c*) Tuberculous.

(*d*) Simple hyperplastic.

(*a*) *Carcinomatous.*—These appear in the neck as an early manifestation of the presence of a carcinoma in the respective territories drained

by the cervical lymph-nodes (Fig. 71). The primary carcinoma may be comparatively easily found, so that the diagnosis is not difficult. But there are cases where the secondary lymph-node involvement is the first evidence that a carcinoma exists and the primary growth may be quite small. The characteristics of carcinomatous lymph-nodes are that they are extremely hard, the skin is movable over them, and they are easily movable upon the underlying and surrounding structures. The enlargement may be confined to the lymph-nodes of one region (Fig. 71), for example, submaxillary or deep cervical, or may be present on both sides of the neck.

FIG. 110. ENLARGEMENT OF THE SUBMENTAL LYMPH-NODES THE RESULT OF TUBERCULOUS LYMPHADENITIS.

The diagnosis can be made (*a*) from the extremely firm consistency of the tumors situated in places where the various lymph-nodes are normally found, (*b*) the age—usually above forty, (*c*) presence of cachexia, (*d*) negative findings in the blood, and (*e*) the discovery of the primary focus. In the later stages, when ulceration of the overlying skin has taken place, the case may impress one as a primary branchiogenic carcinoma of the neck, but these are extremely rare. (Fig. 111. In some cases one is justified in making a diagnosis of a primary growth, if a careful search has failed to reveal any other primary focus. The only conditions which could be confused with carcinomatous lymph-nodes are those cases of primary branchiogenic carcinoma which have not broken through the skin. These are always deeply situated along the middle of the sternocleidomastoid, but differ from secondary carcinomatous lymph nodes by being firmly attached to the deeper structures of the neck. In every case of suspected carcinomatous enlargement, one should

examine systematically the various structures of the head where a primary carcinoma occurs, not omitting a search in the sinus pyriformis, anterior wall of the pharynx, and interior of the larynx.

(*b*) *Syphilitic Lymph-node Enlargement.*—These occur in the primary stage, secondary to a chancre of the lips, tongue (Fig. 88), or other forms of extragenital infection of the head or neck. The finding of the primary focus and its recognition as syphilitic in nature will render the diagnosis easy. In the secondary stage of syphilis there is occasional enlargement of a few of the lymph-nodes of the neck. The presence of secondary eruptions on the skin or mucous membrane often accompanies this condition and in their absence the only forms which need to be differentiated from them in this secondary stage are simple hyperplastic lymph-nodes, which are usually much firmer and smaller. In the tertiary stage, one will rarely encounter enlargement of the deep cervical or internal jugular lymph-nodes, which cannot be distinguished, in the absence of a history of syphilis, from simple hyperplastic or tubercular nodes until ulceration of the skin has occurred. At such a time the aspect of the ulcer will remove any doubt about the diagnosis. It has the typical appearance of the syphilitic processes in the tertiary stage elsewhere. The edges are somewhat copper-colored and indurated, but not as much so as in the case of a carcinoma. They show the characteristic steep edges of a syphilitic ulcer and the cutaneous ulceration is always more extensive than in the case of tuberculosis. In doubtful cases, the administration of iodid of potassium will cause a speedy healing of the enlarged node or ulcer, as the case may be.

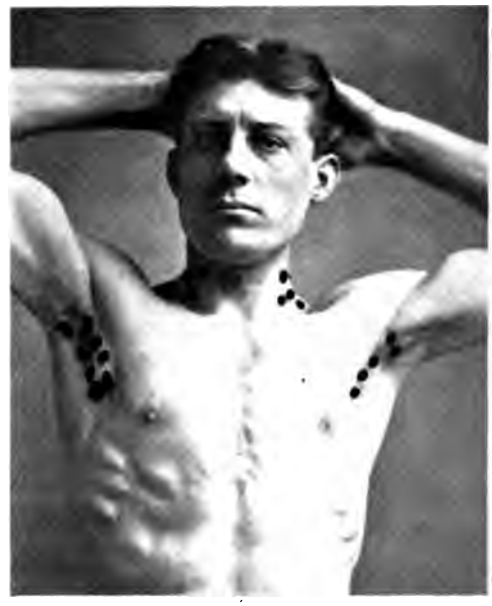

FIG. 117.—DISTRIBUTION OF ENLARGED LYMPH-NODES IN A CASE OF THE PSEUDO-LEUKEMIC FORM OF TUBERCULOUS LYMPH-NODES.

(*c*) *Tuberculous Lymph-node Enlargement.*—As a rule, tuberculosis of the cervical lymph-nodes appears in a chronic form, with the following

clinical picture: In the submaxillary region or along the anterior or posterior borders of the sternocleidomastoid, or in the posterior triangle of the neck, one finds slowly enlarging, soft, non-adherent tumors, which soon coalesce, becoming adherent to each other, and to the surrounding tissues and skin. This adhesion of the skin may not take place until the enlargement has become quite advanced. At an early period there is softening and pus formation and the caseous gland becomes adherent to the surface (Fig. 115), fluctuation becoming distinct. Unless surgical measures are undertaken at this stage, the cheesy pus discharges through the skin and a tuberculous sinus forms. The diagnostic points of the chronic form of tuberculous lymph-nodes are the slowly forming, soft tumors, which show a great tendency to softening and pus formation. There are no evidences of inflammation of the overlying skin until the node becomes adherent to it, when the skin becomes of a bluish color, and there is quite distinct fluctuation. Before making a positive diagnosis, however, of tuberculous infection, *a careful search should be made for primary foci* such as a diseased pharyngeal tonsil (adenoid vegetations) or of enlarged caseous tonsils, or of a chronic middle-ear suppuration. These three are the most frequent infection atria for tuberculous cervical lymph-nodes (see Fig. 105). The less frequent ones are the teeth and tongue. If a sinus has formed, it can be recognized as tuberculous by its bluish undermined edges and the presence of flabby, caseous granulations lining the opening in the skin. This form of lymph-node enlargement occurs most frequently during the first twenty years of life, but must be thought of in examining any case, even at a later period. The *acute form* of tuberculous enlargement of the lymph-nodes is not frequent. The clinical picture is that of a rapid enlargement of the submaxillary and deep

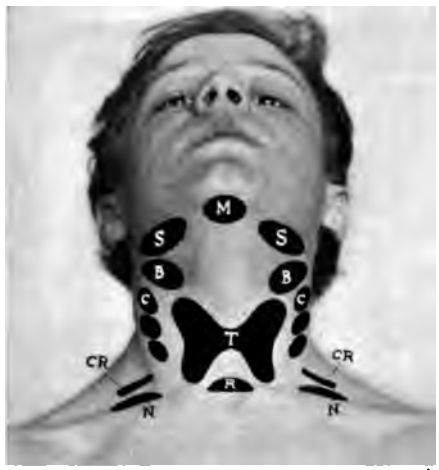

FIG. 118.—ANTERIOR VIEW OF LOCATION OF VARIOUS FORMS OF TUMORS OF THE NECK (diagrammatic).

M. Dermoid cysts and enlargements of the submental nodes; *S*, tumors and inflammatory enlargements of the submaxillary lymph-nodes and salivary glands; *B*, most frequent location of branchial cysts and parathyroids, *C*, enlargements of the deep cervical lymph-nodes; *T* tumors of the thryoid; *CR*, cervical rib; *N*, subclavian aneurysms; *R*, retrosternal goiter.

cervical lymph-nodes, accompanied by a high continous fever, with morning remissions in some cases. In others there is only a moderate degree of fever. It can be differentiated from the other acute forms of infective lymph-node inflammation by the absence of a primary pus focus in the skin or mucous membranes of the nose or throat. There is also less pain and swelling of the surrounding structures. The nodes soon become adherent to each other, pus formation occurs, and the course of the disease, such as sinus formation and discharge through the skin, is the same as in the chronic form. During epidemics of so-called glandular fever, more properly called Pfeiffer's disease, such cases of acute tuberculous cervical lymph-nodes are apt to be interpreted as this disease, and vice versâ.

Pfeiffer's disease, or acute glandular fever, is usually accompanied by more constitutional symptoms, such as a rapid pulse and higher temperatures, there is less tendency to suppuration, and the nodes do not become adherent to each other. There is not infrequently the history of an epidemic of this disease.

The *pseudo-leukemic form of tuberculous lymph-node enlargement* greatly resembles (Fig. 108) true pseudo-leukemia or malignant lymphoma. It not infrequently involves lymph-nodes on both sides of the neck as well as those of the axillary and inguinal regions, but there is not the same tendency to progressive enlargement as is the case with true pseudo-leukemia. The only crucial test in moderately advanced cases is by the excision of one of the nodes, and its inoculation into a guinea-pig. This pseudo-leukemic form of tuberculous lymph-node inflammation has been fully described by G. Fischer.[1] Its clinical recognition is of considerable importance, as many such cases are erroneously diagnosed as true pseudo-leukemia. The characteristic difference between the two is the less marked enlargement of the lymph-nodes in tuberculosis, the fact that the mediastinal and abdominal nodes are never involved, and that there are no pressure symptoms, no anemia, or cachexia.

The differentiation of chronic tuberculous lymph-nodes must be made (*a*) from syphilitic, (*b*) from malignant (most often lymphosarcoma, rarely carcinoma), (*c*) from pseudo-leukemic, and (*d*) from leukemic enlargement. This differentiation has been referred to under the separate groups.

Simple Hyperplastic Lymph-nodes.—This last form of lymph-node enlargement is characterized by the presence of painless soft nodules, in the usual location of the cervical lymph-nodes. Rarely they are firmer in consistency. The diagnosis can be made from the fact that

[1] "Deutsche Chirurgie," Lieferung 34.

they are painless, show no tendency to breaking down, are freely movable, not matted together, and cause no symptoms.

TUMORS OF THE NECK.

Examination.—In examining a tumor of the neck for diagnostic purposes one should conduct the examination in a systematic manner as follows:

1. The history of the case.
   - (*a*) The age of the patient.
   - (*b*) When did the tumor appear? Was it present at birth or shortly after? Did it appear at infancy, at or near puberty, middle or old age?
   - (*c*) Has the growth of the tumor been rapid or slow?
   - (*d*) Where did the tumor first show itself?
   - (*e*) History of trauma, etc.
   - (*f*) Is the tumor subject to attacks of inflammation? (This is frequently the case in lymphangiomata.)
2. Physical examination.

A. Inspection:

I. Location of the tumor. This is easy to note unless the tumor spreads over both sides of the neck. The various regions in which the various tumors of the neck occur most frequently, are:

- (*a*) Submaxillary and submental regions (lymph-nodes, tumors of the jaw, dermoids of the floor of the mouth, branchial cysts, thyroglossal cysts, lipomata).
- (*b*) Along the course of the trachea and the larynx (goiter, thyroglossal cysts, thyrohyoid bursæ).
- (*c*) Along the carotid sheath (lymph-nodes, sarcomata (deep), tumors of the carotid body, aneurysms, angiomata, branchial cysts and branchiogenic carcinomata, pressure diverticula of the esophagus, osteomata of the spine).
- (*d*) Supraclavicular fossa (lymph-nodes, aneurysms, osteomata, cervical ribs).
- (*e*) Suprasternal fossa (retrosternal goiter and aneurysms).

II. Consistency of the skin over the tumor.

- (*a*) Whether it is bluish or reddened, whether movable over the tumor or adherent to it, whether ulcerated or marked by dilated veins.

B. Palpation:

- (*a*) The consistency of the tumor. Whether it is hard or soft, semi-fluctuating, or cystic.

(*b*) Whether it is adherent or movable to the underlying tissues and skin covering it.

(*c*) Its relation to the trachea as determined by the swallowing test (see page 198)—a symptom frequently pathognomonic of goiters.

(*d*) Pressure symptoms on the trachea, vessels, or nerves, and upon the esophagus.

(*e*) Examination for the presence of expansile pulsation and thrill—a sign characteristic of aneurysm.

(*f*) Condition of surface of tumor, whether smooth or nodulated.

(*g*) Whether larger after eating and then smaller again as is the case in pressure diverticula of the esophagus.

FIG. 109.—LATERAL VIEW OF MOST FREQUENT SITUATIONS OF TUMORS OF THE NECK.

P, Parotid tumors; *S*, submaxillary neoplasms and lymph-node enlargements; *T*, enlargements of lateral lobes of thyroid; *C*, the many black areas correspond to the locations of the larger of the deep cervical nodes under the sternocleidomastoid muscle and in front of and behind it; *A*, lymph-nodes in posterior triangle of neck; *N*, subclavian aneurysm.

C. Examination of Blood, Spleen, Mouth, and of Body in General.—In every case of tumor of the neck, one should not omit the general examination of the patient. This should include (*a*) the mouth, ear, nose, and throat, with the aid of the special instruments required for these purposes; (*b*) the blood for evidences of leukemia, anemia, or leukocytosis; (*c*) the condition of lymph-nodes in other parts of the body, *e. g.*, the axillæ, inguinal regions, pelvis, and mesentery; (*d*) the spleen, whether enlarged or not, as a part of the clinical picture of a pseudoleukemia or of some cases of lymphatic leukemia; (*e*) the presence or absence of cachexia, etc.

D. Auscultation and Percussion.—These are of little value in the diagnosis of tumors with the exception of the bruit heard over aneurysms of the common carotid and subclavian arteries.

Classification.—Tumors of the neck are most conveniently divided into the cystic and solid varieties for diagnostic purposes.

	Cystic.	Solid.
I. Those which are congenital in origin.	1. Branchial cysts.	1. Lipoma—solitary, diffuse or symmetrical.
	2. Thyroglossal cysts.	2. Fibroma.
	3. Lymphangioma cysticum.	3. Lymph-nodes—tuberculous, syphilitic, or leukemic, lymphosarcoma (see page 177).
	4. Hemangioma cavernosum and blood-cysts.	4. Osteoma.
	5. Thyrohyoid bursæ.	5. Chondroma.
	6. Cystic goiter.	6. Sarcoma, including tumors of the carotid body.
	7. Diverticula of the esophagus.	7. Carcinoma— Primary: From the skin or branchiogenic in origin. Secondary: From primary focus in head, larynx, thyroid, esophagus, or breast.
II. Non-congenital....	8. Cysts of accessory thyroids.	8. Tumors of the submaxillary salivary gland.
	9. Echinococcus cysts.	9. Goiter, benign and malignant.
	10. Sebaceous cysts.	10. Aneurysms of common carotid or subclavian arteries.
	11. Dermoid cysts.	11. Primary tumors of the parotid extending to the neck.
	12. Suppurating lymph-nodes (most often of a tuberculous nature).	12. Enlarged accessory thyroids.

Cystic Tumors.

The chief characteristics of the various forms of cystic tumors of the neck are:

1. **Branchial Cyst.**—These are generally located in the submaxillary region (Fig. 120) or along the middle of the inner border of the sternocleidomastoid. It has the sensation of a tense cyst, is oval, elastic and is firmly attached to the deeper tissues. The skin is movable over it unless suppuration has occurred. They appear at birth but may not begin to enlarge sufficiently to be recognized until adult life. The contents may be serous, mucoid, or sebaceous material. They are most often unilocular.

2. **Thyroglossal Cysts.**—These are always in the median line

between the hyoid bone and the middle of the trachea. They are

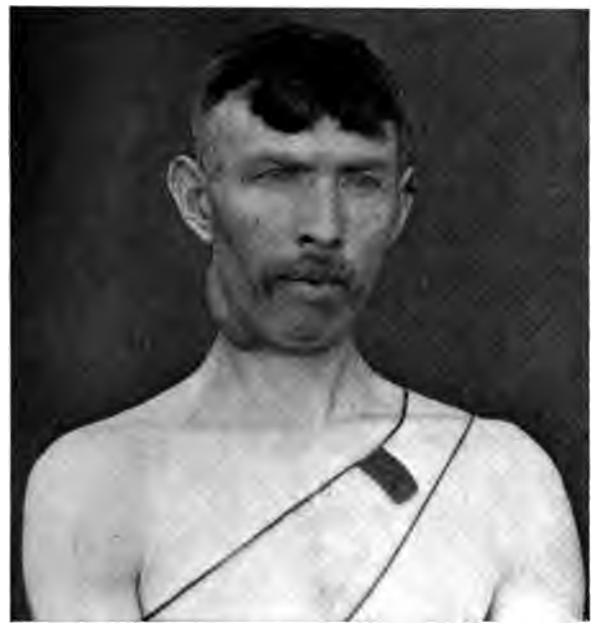

FIG. 120.—FRONT VIEW OF BRANCHIAL CYST.

FIG. 121.—SIDE VIEW OF A UNILOCULAR BRANCHIAL CYST.
Observe its position in the superior carotid triangle of the neck.

unilocular like the branchial cysts, are usually small, and move upward when the patient swallows. They cannot be distinguished from cystic lymphangioma, except by microscopic examination and by the fact that the latter neoplasm (lymphangioma) is usually quite diffuse.

3. **Congenital Cystic Lymphangioma (Cystic Hygroma).**—These may occur either as unilocular or multilocular tumors, most frequently situated in the submaxillary region. Less often they are found beneath the occiput and in the supraclavicular region. They arise from enormously dilated lymph-vessels and vary from a small tumor to one occupying half of the neck (Fig. 122). They push their way like the hemangiomata between various structures of the neck, but rarely cause compression symptoms. They are, however, subject to recurrent attacks of inflammation, during which they increase in size and the skin over them becomes reddened.

FIG. 122.—CONGENITAL CYSTIC LYMPH HEMANGIOMA OF NECK.

They are almost always present at birth. They cannot be differentiated from those branchial cysts of the submaxillary region which are present at birth, except by the fact that their contents is a clear serous fluid while that of the branchial cysts may be pure serum or mucus or sebaceous material with or without hair. Branchial cysts are more circumscribed and never attain the size of a lymphangioma.

4. **Hemangioma.**—This variety of tumor occurs in two forms in the neck:

(*a*) *Cavernous Hemangiomata.*—These are multilocular and may occupy one side of the neck (Fig. 122), contain blood and grow between all of the tissue, but they rarely cause pressure symptoms. A simple capillary angioma occurs quite rarely in the neck.

(*b*) *Unilocular or Blood-cysts.*—These vary from a walnut to a child's head in size, are movable, and not attached to the skin. They often

cause pressure symptoms such as dyspnea and dysphagia. They must be differentiated from aneurysms, cavernous angiomata, and lipomata. In the first-named there is a bruit, thrill, and expansile pulsation. In the cavernous angiomata there is a history of their presence at birth and they are multilocular. The lipoma is firmer and quite rare in the regions in which blood-cysts are found.

5. **Thyrohyoid Bursæ.**—These occur most frequently over the thyroid cartilage (bursa ante-thyroidea) or on the thyrohyoid membrane. They are the size of a small nut and accompany the movements of the thyroid in swallowing, and are apt to be painful at times in rheumatic persons. They must be differentiated from cysts of an aberrant or accessory thyroid.

6. **Cystic Goiter.**—This usually involves one or both of the lateral lobes of the thyroid. It may be of large size and cause considerable elevation of the skin (Fig. 123). It gives a distinct sense of fluctuation and moves upward during the act of swallowing.

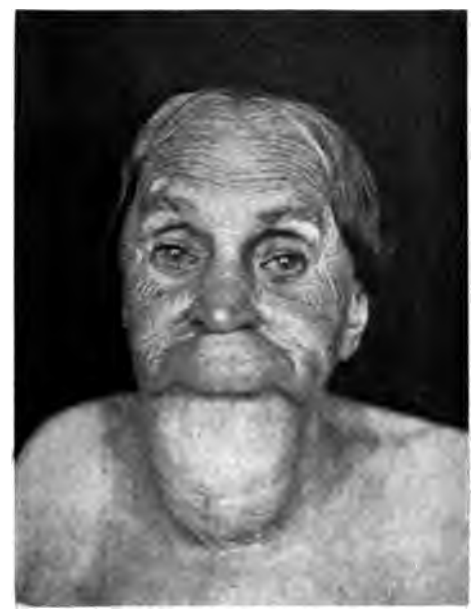

FIG. 123.—ANTERIOR VIEW OF AN ENORMOUS CYSTIC GOITER.

It occupied all the space between the sternocleidomastoid muscle on either side, the lower jaw above, and the sternum below, and contained a brownish gelatinous fluid with cholesterin crystals

7. **Diverticula of the pharynx or esophagus** are always on the left side and there is a history of their alternately full and empty condition. They are quite rare in the neck.

8. **Cysts of the Accessory Thyroids.**—These are found in the typical location of these structures (Fig. 118) and are quite small and appear usually after the age of puberty. They are very rare.

9. **Echinococcus cysts** are quite rare and are found close to the sheath of the carotid vessels or in the sternomastoid itself. They cannot be differentiated from tuberculous lymph-node abscesses, except that in the latter there is the history of a solid tumor which has softened and is quite adherent. This speaks for tuberculosis.

10. **Sebaceous Cysts.**—These are quite superficial, small, and stretch the overlying skin over them considerably. They may also be adherent to the skin.

11. **Dermoid cysts** occur in the median line, especially just below the chin. They are firmer and more doughy in consistency than any of the other cysts occurring in these locations.

Solid Tumors.

1. **Lipomata.**—These usually occur as subcutaneous or intermuscular soft elastic tumors, not adherent to the skin. They may occur as solitary tumors upon one side of the neck or as larger, more diffuse tumors. They are usually more or less fixed at their base and when the skin is stretched over them during examination, showing a distinct division into lobules. They may attain an enormous size. They also tend to develop into the depth, growing in between the various structures.

Fig. 124.—Large Cystic Goiter.

Extending from level of lower jaw almost to sternum. This patient also had a marked kyphosis, due to old age. (Side view of same patient shown in Fig. 123.)

A form of diffuse lipoma (Fig. 125) may occur in which the fatty tissue grows indiscriminately between the other structures of the neck, burrowing between the muscles and vessels. This condition may be present in connection with a peculiar form of multiple fatty tumors situated more or less symmetrically over the entire body and called symmetrical lipomatosis. A deep or subfascial form also rarely occurs which simulates the softer forms of solid tumors, such as goiter or tense cystic tumors.

2. **Chrondromata** are very rare and arise from aberrant islands of cartilage in the vicinity of the parotid. The skin is movable over them and their firm consistence, like that of the cartilage of the nose, is quite typical. They occur in young people.

3. **Osteomata** usually occur in the lower part of the neck as out-

growths from the spine, ribs, and clavicles. Their bone-like consistency, location, and fixation aid in differentiating them from every other form of solid tumors, even without the use of the *x*-ray. The only condition which resembles an osteoma at the base of the neck is a cervical rib, which was described on page 161. Such a supernumerary rib is thinner and more frequently causes pressure of the adjacent nerves and vessels than an osteoma.

4. **Fibromata.**—These usually occur as soft pedunculated tumors of the skin, often associated with a generalized condition of fibroma molluscum (Fig. 441).

5. **Solid Tumors of the Submaxillary Salivary Gland** (Fig. 126).—These appear in the typical location of the submaxillary salivary gland just below the lower jaw close to its angle. They are either chondromata or mixed tumors and must be differentiated from enlargement of the submaxillary lymph-nodes due to tuberculosis or malignant disease (such as carcinoma). The former may be excluded by the firm consistency of the tumor and the latter by the absence of a primary growth.

FIG. 125.—SYMMETRICAL LIPOMATOSIS.

In this case the entire neck from the sternocleidomastoid on each side was occupied by a diffuse lipomatous tumor. Lipomata were distributed symmetrically over both deltoid regions, over the abdomen on either side of the median line, and over both gluteal regions.

6. **Goiter.**—Here the tumor is situated in the region usually occupied by the thyroid gland along either side and across the middle of the trachea (Fig. 133. It may be soft or quite firm, varying in this respect according to whether it is parenchymatous, colloid, or fibrous in character. When the patient swallows a glass of water the tumor moves upward on account of its attachment to the trachea. The skin is movable over the tumor. Goiter is considered separately on page 198.

7. **Sarcomata.**—These arise in the deeper parts of the neck and grow toward the surface. They may arise from the following structures:

(*a*) The carotid body.

(*b*) The connective tissue of the carotid sheath.

(*c*) From the cervical lymph-nodes.

(*d*) From the thyroid gland.

(*a*) *Tumors Arising from the Carotid Body* (also called Luschka's gland).—These are usually endotheliomata and appear in middle-aged or old people. The tumor may remain quite small and benign for many years, and then suddenly begin to grow and pursue a rapidly malignant course. It is situated at the point of bifurcation of the common carotid artery. It invades the vessel sheath in its growth. The tumor is soft and

FIG. 126.—SOLID TUMOR OF THE SUBMAXILLARY SALIVARY GLAND.
This illustration shows how these tumors appear to come from behind the lower jaw, projecting outward in the submaxillary region. (See text.)

compressible, attaining the size of a hen's egg, and shows no expansile pulsation or thrill like an aneurysm. It is much firmer than a branchial cyst, appears at a later period in life, and grows more rapidly. It has a transmitted pulsation due to its relation to the larger vessels of the neck.

(*b*) *Sarcomata arising from the carotid sheath itself* grow rapidly and are firmly fixed to the deeper structures of the neck, although they are not adherent to the skin until a later period when they may ulcerate and present a sloughing mass. They cause pressure symptoms such as dysphagia, dyspnea, neuralgia, and paralysis of the recurrent laryngeal nerve at an early stage of their growth.

They are of firm consistency and usually occur in middle-aged or old persons. Their location under the sternocleidomastoid muscle, rapid growth, fixation to the deep structures, and pressure symptoms render their diagnosis comparatively easy. Lymphosarcomata and sarcoma of the thyroid are discussed on page 201.

FIG. 127.—ANTERIOR VIEW OF CARCINOMA OF THE THYROID.

Causing displacement of the trachea (*T*) to the left: *G*, Secondary enlargement of the cervical lymph-nodes, of a carcinomatous nature.

9. **Carcinoma.**—This form of tumor of the neck may be primary or secondary. The former is very rare and may arise in the skin either (*a*) from an old ulcer or a scar or (*b*) in the deeper tissue from the branchial fistulæ or from aberrant thyroids.

(*a*) *Primary Carcinoma.*—The cutaneous carcinomata present the same characteristics as elsewhere. The deeper forms of primary carcinoma are usually rapid in their growth and located just below the angle of the jaw or at the middle of the sternocleidomastoid muscle at the same location as the branchial cyst (Fig. 120). They occur late in life and become adherent to the vessels early and cause ulceration of the skin, with everted hard edges (Fig. 111). The diagnosis of a primary branchiogenic carcinoma may be made if the growth has the typical induration of carcinoma, situated in the usual cyst location of a branchial cyst. They are fixed and cause pressure symptoms only at a late period. The growth is harder than a sarcoma and there is often involvement of the regional lymph-nodes (deep cervical).

Primary carcinoma of the thyroid is situated lower in the neck. It is attached to the trachea and soon displaces the latter (Fig. 127).

(*b*) *Secondary Carcinoma.*—This form of solid tumor can be readily diagnosed from the fact that it involves the lymph-nodes draining the mouth, nose, ear, pharynx, or thyroid (Fig. 105). The secondary carcinomatous tumors are very hard, cause early pressure symptoms, and like the sarcomata and primary carcinomata ulcerate quite early. The diagnosis can be made from the consistency of the tumor and its location. The latter corresponds with that of the submaxillary, or deep cervical lymph-nodes. One should search for a primary growth in the head, larynx, esophagus and thyroid, breast or stomach (supraclavicular nodes). The latter is a rare occurrence.

FIG. 128.—LATERAL VIEW OF CASE OF CARCINOMA OF THE THYROID.

At times the external tumors may be enormous and even bilateral and the primary growth be an insignificant one, hidden in some obscure place like the sinus pyriformis or the anterior wall of the pharynx. One should always examine in their order: the face, mouth, tongue, nasopharynx, larynx, esophagus, ear, salivary glands, thyroid, and rarely the stomach.

Primary carcinoma of the esophagus may at times first involve the deep cervical nodes to such an extent that the tumor is diagnosed as a primary one of the submaxillary salivary gland.

The secondary carcinomatous nodes are often movable and painless for a considerable period and may be the first sign to direct suspicion toward a malignant growth in the region which they drain. They are much firmer than tuberculous nodes and the latter are infrequent at such a late period of life. Primary branchiogenic carcinomata, as was stated above, become adherent quite early to the vessels and cause severe pain.

CYSTIC TUMORS OF NECK.

	Most Frequent Location.	Age.	Mobility.	Pressure Symptoms.	Results of Palpation.
1. Branchial cysts.	Submaxillary region and middle of sternocleidomastoid.	Adults, rarely present at birth.	Fixed in the depth. Skin movable over it.	None.	Usually unilocular.
2. Thyroglossal cysts.	Median line between hyoid and middle of trachea.	Same as above.	Same as above.	Same as above.	Move upward when swallowing, otherwise same as above.
3. Lymphangioma.	Submaxillary region, but may spread. Less often supraclavicular.	Present at birth.	Fixed in depth but skin movable over it.	Present if of large size.	May be uni- or multilocular.
4. Hemangioma.	Cavernous. Anywhere in anterior region. Blood-cysts along carotid artery.	Often at birth or early life.	Cavernous attached to skin, blood-cysts to vessels.	Same as above.	Soft, can be reduced in size by pressure.
5. Thyrohyoid bursæ.	Over middle of thyroid.	Adult life.	Fixed to thyroid cartilage or hyoid bone.	None.	Firm cystic tumors. Unilocular.
6. Cystic goiter.	Lateral to middle of or over trachea.	Adults.	Fixed to trachea, otherwise movable.	If large it compresses trachea.	Distinctly fluctuating. Moves with trachea.
7. Diverticula of esophagus.	On left side beneath sternocleidomastoid.	Adults.	Fixed to esophagus and lie very deep.	None.	Alternately full and empty, varying according to feeding.
8. Cysts of accessory thyroids.	At usual location of these.	Adults.	Skin movable. Fixed in depth.	None.	Firm tense cysts. Unilocular.
9. Echinococcus cysts.	In sternocleidomastoid itself or beneath it. Are very rare.	Any age, but usually adults.	Skin movable. Fixed in depth.	None unless very large.	Unilocular. Tense cyst. May rupture spontaneously.
10. Sebaceous cysts.	Anywhere, but usually between sternocleidomastoids.	Adults.	Usually adherent to skin and very superficial.	None.	Soft tumor. Unilocular.
11. Dermoid cysts.	In median line of submental region.	Any age, but usually young adult.	Skin movable. Fixed in depth.	None unless very large, then dyspnea, dysarthria and dysphagia.	Firm, doughy consistency. Unilocular.

SOLID TUMORS OF THE NECK.

	Most Frequent Location.	Age.	Mobility.	Pressure Symptoms.	Results of Palpation.
1. Lipomata.	Single tumors or diffuse under chin.	Adult.	Movable unless diffuse.	None unless of diffuse variety.	Soft-lobulated growth very slow.
2. Fibromata.	As a part of fibroma molluscum, anywhere.	Adult.	Movable with skin.	None.	Firm or soft.
3. Lymph-nodes non-malignant.	In submental and submaxillary regions, along carotids, and above clavicles.	Any age.	Mobility varies (see page 175).	None except in Hodgkin's disease or lymphosarcoma.	Varies, but usually soft or fluctuating.
4. Osteoma.	Above clavicles or along spine.	Adult.	Fixed.	None except neuralgic pains. Very slow growth.	Very hard.
5. Chondroma.	In parotid and submaxillary regions from islands of cartilage.	Any age.	Fixed in depth but skin movable.	None.	Consistency of cartilage.
6. Sarcomata.	Along lymph-nodes (lymphosarcoma), at bifurcation of carotids or along large vessels.	Adult.	Fixed in depth, often ulcerate skin.	Quite early pressure on trachea, esophagus and vessels.	Grows rapidly. Consistency varies from soft to firm.
7. Carcinomata.	Primary, same location as branchial cysts or in skin, thyroid. Secondary in lymph-nodes.	Old age.	Fixed in depth in early stage, later universally adherent.	Same as above. In primary a rapid growth. Late pressure symptoms in secondary.	Very hard and nodular. Regional infection of lymph-nodes in primary.
8. Tumors of submaxillary salivary gland.	Below angle of jaw.	Adult.	Skin movable, fixed to lower jaw.	None unless very large.	Firm consistency.
9. Goiter.	Sides of trachea or over middle of same.	Any age after puberty.	Skin movable. Attached to trachea. (Try the swallowing test.)	Varies as to size first on trachea.	Consistency varies according to whether parenchymatous, colloid, fibrous, or malignant.

10. Aneurysms.	Along carotids or subclavians.	Adult.	Skin movable. Adherent at depth.	None unless quite large.	Expansile pulsation, thrill, and murmur.
11. Primary tumors of parotid.	Begin in parotid and then invade neck.	Any age, but usually adult.	Fixed to deep tissues only.	None unless very large. Rapid growth.	Very firm, often like cartilage (see page 157).
12. Goiters of accessory or thyroids.	At location of these.	Adult.	Same as above.	Slow growth and no pressure symptoms.	Firm, often nodular.

Diseases of the Thyroid Gland.

The thyroid gland is composed of a lateral lobe lying upon either side of the trachea and a median isthmus. The gland parenchyma contains a large percentage of iodin, so that it is now generally accepted that its secretion assists in metabolism. Behind the lateral lobes lie the four parathyroid bodies. Their removal during a thyroidectomy causes the condition known as tetany.

Absence or lack of perfect development of the thyroid gland causes a congenital condition known as cretinism, or cachexia strumipriva (see Fig. 129). It may follow removal of the entire gland. The symptoms of this loss of function of the thyroid are: (*a*) retarded growth; (*b*) a waxy, soft skin; (*c*) a small, low-tension pulse with attacks of syncope; (*d*) apathy or defective mentality.

Fig. 129.—Cretinism or Cachexia Strumipriva.
Gründler's case ("Beiträge zur klin. Chirurgie," vol. i).

Enlargements of the thyroid gland are called goiters. They may be of benign or malignant nature. If accompanied by symptoms due to excessive thyroid secretion, the resultant group of symptoms is called *Exophthalmic goiter*, or *thyrotoxicosis*, or *hyperthyroidism*.

Non-malignant Goiter.

This may involve the thyroid gland proper, or one of the accessory thyroids. The patho-

logic changes are the same in both, and the diagnosis of which one is involved can only be made from the location.

The chief questions in every case of non-malignant goiter are:

(*a*) Whether the suspected tumor is a goiter.

(*b*) What is the extent of the involvement and the variety?

(*c*) Are pressure symptoms present or is it a part of an exophthalmic goiter case?

A goiter of the accessory thyroids will have all the clinical characteristics of the true goiter, but its situation is different and it is not attached to the trachea.

FIG. 130.—SCHEMATIC REPRESENTATION OF COMPRESSION AND ROTATION OF THE TRACHEA FROM UNILATERAL GOITER (Kocher).

A goiter involving the thyroid gland proper causes a prominence in the lower portion of the neck (Fig. 131) best seen when looked at from the side. It may be most marked in the median line if it involves the isthmus or more on one side if one lobe is involved, or be butterfly-like causing a prominence on both sides connected by a bridge (Fig. 134).

Tumors of the thyroid, unless a brawny, board-like infiltration exists, move upward with the trachea. This can be determined by permitting the patient to swallow some water while the tumor is grasped with the fingers (Fig. 135). This is absent in goiters of the para- or accessory thyroids.

The extent of involvement can be ascertained by flexing the head upon the neck and palpating the tumor while standing behind the patient.

The varieties of enlargement are:

1. *Simple Parenchymatous.*—This occurs at any age but is especially frequent in young people. It usually involves the entire gland, is soft and smooth, and rarely causes pressure symptoms. It may give the sensation of fluctuation. Any of the other forms may develop in it. It may begin during adolescence or pregnancy and remain stationary.

2. *Thyroid Adenoma.*—This is the most frequent form. It causes firm, nodular tumors, whose outlines are quite sharp. It often contains small cysts and its acini, which resemble those of the normal thyroid, may coalesce to form large fluctuating cysts forming very prominent

tumors (Fig. 123). This form (adenoma) involves only a portion of the gland, either one lobe (Fig. 131) or the isthmus. Pressure symptoms such as dyspnea are marked if it compresses the trachea. If smaller or larger collections of colloid material occur it gives it a doughy consistency.

3. *Fibrous Goiters.*—These occur as enormously hard nodules or as a diffuse induration of one lobe or of the entire gland. In the latter form they cause pressure symptoms quite early. This form is often associated with symptoms of hypothyroidism.

FIG. 131.—FRONT VIEW OF GOITER.

The enlargement involved the isthmus and left lobe. The upper line (1) shows how much tumor rises during the act of swallowing from its normal position at (2).

FIG. 132.—LATERAL VIEW OF GOITER SHOWN IN FIG. 131

Showing most frequent position in neck of goitrous enlargements.

4. *Vascular Goiters.*—This variety presents a distinct pulsation or thrill of the goiter due to the enlargement of the vessels. There are murmurs to be heard over the tumor.

Pressure symptoms are most marked if the posterior part of one or both lateral lobes are involved, or if there is a retrosternal goiter. These pressure symptoms are:

(*a*) Those due to pressure on the trachea. The trachea is either curved to one side (Fig. 130) or it is rotated or it is bilaterally compressed (saber-sheath trachea). If moderate there is dyspnea, cyanosis, and some stridor. If the pressure is of high degree asphyxia may result.

The extent of this pressure on the trachea may be ascertained by a laryngoscopic examination, by the degree of dyspnea and the use of the *x*-ray as recently suggested by von Bruns.

FIG. 133.—PARENCHYMATOUS GOITER.

Causing enlargement of right (*R*) and left (*L*) lateral lobes and isthmus (*M*) of thyroid. The palpable outlines of the tumor are traced upon the neck in black.

(*b*) Pressure on the recurrent laryngeal nerve. This is quite rare and causes hoarseness, a brassy cough, and aphonia. Death may ensue suddenly from spasm of the glottis.

(*c*) Pressure on the sympathetic is also rare and causes vasomotor disturbances of the skin of the face and neck and a dilatation of the pupil on the side upon which pressure is exerted.

(*d*) Pressure on the esophagus is less frequent than any of the above and results in difficulty in swallowing.

A **retrosternal goiter** produces dullness over the manubrium (Fig. 167), may cause pressure on the trachea, and this tracheal stenosis be the only symptom. It may also compress the large veins, the innominate artery, and the esophagus.

The diagnosis of the presence of a retrosternal goiter can only be made from the pressure signs and the *x*-ray.

A retrosternal goiter must be differentiated from other varieties of mediastinal tumors, such as sarcomata, aneurysms, and esophageal diverticula which could produce the same symptoms (see page 376). In retrosternal goiter the dyspnea is

FIG. 134.—LATERAL VIEW OF SAME CASE SHOWN IN FIG. 133, OF PARENCHYMATOUS GOITER INVOLVING ISTHMUS AND LATERAL LOBES.

intermittent, varying with the rise and fall of the tumor during respiration.

Retrotracheal and retroesophageal goiters also occur and encircle the corresponding structures.

Malignant Goiter.

Both sarcoma and carcinoma occur rather infrequently. Sarcoma occurs at an earlier age (thirty to fifty) than carcinoma (forty to sixty). Sarcoma grows more rapidly than carcinoma and attains a much larger size. Both can be distinguished from non-malignant goiters by the fact that they cause a steady, at times quite rapid, enlargement of the gland and the pressure symptoms on trachea, esophagus, nerves and blood-vessels, especially the internal jugular, are very marked (Fig. 127). Both forms of neoplasm are much harder than the ordinary forms of goiter. Sarcoma causes a uniform enlargement, while carcinoma is quite nodulated, accompanied by enlarged hard lymph-nodes, and is very painful.

Fig. 135.—Method of Grasping Tumors of the Thyroid to show their Relation to the Trachea.

The lobes of the enlarged thyroid are grasped between the index-finger and thumb, and the patient instructed to swallow. During the act of swallowing the tumor moves distinctly upward, and sinks again after cessation of the same.

Carcinoma of the thyroid produces early metastases in the long bones and skull.

One must suspect a malignant change in a goiter if it suddenly begins to grow after the age of thirty-five, according to Kocher.

Thyroiditis and Strumitis.

Inflammations both of the normal thyroid gland and of a goiter may occur. The term "thyroiditis" is employed to indicate an inflammation of a normal thyroid, while that of "strumitis" means an inflammation o

curring in a goiter. The latter is quite rare as an acute condition, but is more frequent in a chronic form than a thyroiditis. The symptoms are identical in both.

They may follow injury to the neck in the vicinity of the gland or occur during the course of some general disease, such as typhoid, malaria, articular rheumatism, scarlatina, variola, and pyemia. The diagnosis presents no difficulties, if one remembers the normal situation of the thyroid. The gland can be felt to be considerably swollen and indurated. It is quite tender and the pains radiate toward the face and the ear. In the very acute cases, there is redness of the overlying skin.

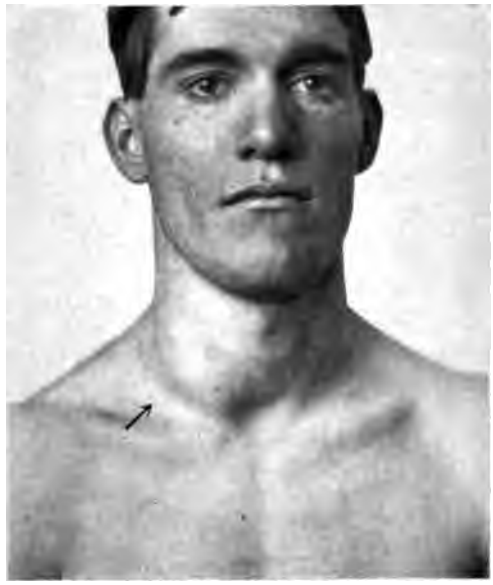

FIG. 136.—UNILATERAL RIGHT-SIDED GOITER.

The arrow points to the tumor along the inner side of the lower portion of the sternocleidomastoid muscle, caused by the goiter.

The leukocytosis, pulse-rate, and temperature vary with the severity of the infection, being higher in the very acute cases. The swollen gland may compress the trachea and esophagus and cause transitory symptoms of stenosis, dyspnea, and dysphagia respectively. If the inflammation goes on to suppuration, the surrounding tissue becomes edematous and tender and pus forms in the gland. This may be ascertained by the persistence of the temperature and the increase of the local signs and leukocytosis.

The pus may escape externally through perforation of the skin or rupture into the trachea, esophagus, or mediastinum.

Syphilis of the thyroid is very rare.

Tuberculosis of the thyroid is also an infrequent condition. It occurs between the ages of thirty and forty and causes caseous deposits in the gland with the formation of typical tuberculous sinuses.

Aberrant goiters occur in the region above and below the hyoid bone and in the tongue along the course of the thyroglossal duct. The condition is an infrequent one.

EXOPHTHALMIC GOITER (HYPERTHYROIDISM).

The diagnosis of this condition may be made from the presence of a group of four symptoms, exophthalmos, tachycardia, a goiter, and a fine tremor.

It may occur as a disease without any marked enlargement of the thyroid or be accompanied by any of the various forms of goiter. Usually, however, there is considerable enlargement and vascularity of the gland.

The *exophthalmos* is bilateral and (Figs. 137 and 138) accompanied by certain typical ocular symptoms which, however, are not constantly

FIG. 137.—FRONT VIEW OF CASE OF EXOPHTHALMIC GOITER.

The bulging of the eyes resulting in abnormal separation of the lids is well shown. The thyroid in this case was greatly enlarged, of the parenchymatous variety, and involved both right and left lobes and the isthmus of the thyroid, all of which were quite prominent. The pulse-rate was 152.

FIG. 138.—SIDE VIEW OF CASE OF EXOPHTHALMIC GOITER.

Note the protrusion of the eyeballs and the marked prominence over the thyroid region, due to the presence of a parenchymatous goiter of both lobes and isthmus of the thyroid.

present. These latter are the Stellwag symptom (abnormal wideness of the palpebral opening), the Moebius symptom (a lack of convergence of the two eyes), and the von Graefe symptom (the upper lid does not follow the eyeball when it is moved down). The *tachycardia* varies from ninety to one hundred and forty beats or even higher in severe cases. The face and neck are flushed and there are frequent attacks of profuse perspiration, especially of the extremities. Acute dilatation of the heart may occur at intervals, without any prodromal symptoms.

There is also great irritability, attacks of indigestion and diarrhea. The course of the disease is either acute or there are exacerbations from time to time, and death may occur suddenly from the acute cardiac dilatation.

The goiter is moderately firm, not as large as in ordinary cases, and often so vascular as to show a distinct bruit.

The tremor is of a very fine character, best seen when the hands are extended. There is often great muscular weakness (myasthenia).

From time to time there are attacks of vomiting and diarrhea as well as of palpitation and angina pectoris.

The larval or *formes frustes* of exophthalmic goiter are apt to be overlooked. In these, any of the above symptoms, such as tachycardia, tremor, sweating, and palpitation, may accompany a goiter and not be correctly interpreted as due to it. There are also many cases which pursue a chronic course in which the only symptoms are great vascularity of the goiter, tachycardia and psychic unrest.

FIG. 130.—PERITONSILLAR ABSCESS.

PA, Prominence along anterior pillar of fauces and caused by peritonsillar abscess; *SP*, edematous uvula; *L*, normal left tonsil and pillars of fauces; *T*, tongue.

EDEMA OF THE GLOTTIS.

This is usually secondary to inflammmatory conditions in the vicinity spreading to the loose connective tissue of the aryepiglottic folds. The swelling causes marked dyspnea, cyanosis, and stridor. The symptoms may appear so rapidly that death occurs immediately. The diagnosis may be made from the onset of the above symptoms during the course of a peritonsillar (Fig. 139) or perichondritic suppuration or as a complication of a Ludwig's angina deep phlegmon of floor of mouth) or of ulcerative laryngeal processes.

The diagnosis can be confirmed by laryngoscopic examination. One can see the swollen aryepiglottic folds almost touching each other.

PAPILLOMA OF LARYNX.

This is the most frequent form of benign tumor of the larynx. They occur especially in children on the true vocal cords and are usually multiple. They give rise to symptoms of stenosis and hoarseness and

if pedunculated may fall into the space between the cords and cause asphyxia. By laryngoscopic examination they look like a pink mulberry-shaped tumor situated at the anterior end of one of the vocal cords or scattered diffusely over both the cords.

CARCINOMA OF THE LARYNX.

Carcinoma of the larynx usually occurs late in life. It may be primary, *i. e.*, have its origin within the larynx, or secondary, by extending to it from the tongue, pharynx, or esophagus. The primary is also spoken of as intrinsic, the secondary as the extrinsic form.

The diagnosis may be made from the gradual onset of hoarseness, pain in the larynx radiating to the ears, and dyspnea in elderly men taken in conjunction with the local findings. Later on when the lymph-nodes along the anterior border of the sternomastoid become enlarged and there is expectoration of a fetid, tenacious mucus, with recurrent hemorrhages accompanied by dysphagia and emaciation, the diagnosis is no longer difficult.

The local examination at an early stage, will show one of the following laryngoscopic pictures:

1. A papillomatous growth which has a broad indurated base situated usually on the posterior third of a vocal cord.

2. As a marked thickening and induration of one of the vocal or ventricular bands or aryepiglottic folds. At times one sees in addition to the induration a nodulated condition. The entire thickness of the cord seems to be involved. Later in the disease, the picture is different; one now sees ulcerations with raised and indurated edges. The carcinoma has now begun to grow either through or around the thyroid cartilage and is to be felt externally as a hard mass accompanied by firm enlarged lymph-nodes. In the very advanced stages it may grow toward the trachea, pharynx, or esophagus, and cause corresponding symptoms.

There are a number of conditions from which carcinoma of the larynx must be differentiated. These are benign papilloma, syphilis, and tuberculosis. The first-named occurs very rarely so late in life and according to Bland Sutton any papilloma beyond the age of forty must be looked upon with suspicion.

In regard to the two last-named conditions, tuberculosis and syphilis are always seen as ulcers and seldom as infiltrations and never papillomata. In tuberculosis severe pain, cough, and dysphagia are prominent symptoms. The arytenoids are greatly swollen and club-shaped.

The tuberculous ulceration is very shallow, has no indurated edges, and the larynx is very anemic. Tuberculosis is never primary and is accompanied by signs of pulmonary disease with tubercle bacilli in the sputum. Tuberculous ulcers are multiple while carcinoma occurs in a single place. Tuberculosis has as a favorite seat the interarytenoid space or the arytenoid cartilages. Syphilis is accompanied by signs of the same disease elsewhere and if iodids are given there is marked improvement of the laryngeal condition which causes hoarseness and dyspnea as does carcinoma. The syphilitic ulcerations as elsewhere are deep and the edges are clear cut as though cut out with a die, and may occur anywhere in the larynx, but like tuberculosis are usually multiple. There is no enlargement of the lymph-nodes of the neck.

It must not be forgotten that, as on the tongue, carcinoma may be combined with syphilis. It is almost impossible to diagnose such cases.

CHAPTER III.

THORAX.

INJURIES OF THE BONY WALLS OF THE THORAX.

The diagnosis of whether an injury has occurred and its extent can only be made from a systematic examination of each rib, of its costal cartilages, and of the sternum.

FRACTURES OF THE RIBS.

If the mode of injury has been a blow received from some blunt object or a fall upon the same, the fracture will usually be found at the point of impact. If the thorax has been crushed in a diffuse manner, as in being run over or caught between bumpers, the fracture will usually

FIG. 140.—METHOD OF DETERMINING CREPITUS AND ABNORMAL MOBILITY IN FRACTURE OF THE RIBS.

be found between the midaxillary line and angle of the ribs. Those most often broken are the ribs from the third to ninth inclusive. Only one rib may be broken or a number (six or seven). A single rib may at times be broken in places. The diagnosis of whether there are complications, such as injury of the intrathoracic vessels, pleura, or lung, will be considered on page 209.

The diagnosis of a fracture of a rib depends upon the presence of two classes of symptoms:

1. Those due to the fracture proper, such as pain, crepitus, false point of motion, and deformity.

2. Those due to injury of the thoracic viscera.

1. **Signs Due to the Fracture Proper.**—These are not as easily elicited in the ribs as in the long bones, nor is it necessary to obtain all of them in order to make a diagnosis.

Crepitus can rarely be elicited and no great stress should be placed upon its absence. It can be obtained at times by placing the hand over the suspected point of fracture and asking the patient to breathe deeply. If this does not elicit it, no further effort should be made to obtain it. Occasionally it may be heard with the aid of a stethoscope. A false point of motion may often be obtained by direct palpation over the seat of fracture without causing pain to the patient. Each rib should be examined by palpating it from its anterior to posterior ends for this sign. One must not mistake the apparent yielding of the lower ribs for this sign. During the same manipulation one can usually feel a depression or unevenness in the outline of the ribs if present. The latter is especially true in fractures at the costochondral junction.

On placing one hand in front and the other at the back of the chest and compressing the chest, the patient will experience a sharp pain at the seat of fracture. The diagnosis must at times be made from the presence of pain and deformity alone, with or without accompanying symptoms of intrathoracic complications.

2. **Signs Due to Injury of the Intrathoracic Viscera (i. e., of the Pleura or Lung.**—These are discussed on page 209. They are pleuritic friction rub, hemothorax, pneumothorax, emphysema of the subcutaneous tissues, hemoptysis and pneumonia.

FRACTURES OF THE COSTAL CARTILAGES.

Fractures of the costal cartilages themselves are most common in old age when they are ossified, while in younger persons there is a separation of the cartilage from the ribs. The diagnosis may be made from palpation of the deformity, the cartilage itself being displaced forward, while the rib is pushed backward. There is also local pain and some degree of abnormal motion. Only 80 cases of this form of injury have been reported.

FRACTURES OF THE STERNUM.

Aside from gunshot wounds, these are rare and usually transverse and occur in connection with injuries of the spine as the result of crushing injuries of the thorax. They are most common at the junction of the manubrium and gladiolus, and next most frequent opposite the third

FIG. 141.—ILLUSTRATION OF A CASE OF TRAUMATIC ASPHYXIA (see text) FOLLOWING COMPRESSION OF THE THORAX. (Kindly lent by Drs. H. H. A. Beach and Farrar Cobb, of Boston, from their article in the April, 1904, number of the "Annals of Surgery.")

and fourth ribs. The diagnosis may be made from the severe pain referred to the site of the injury and the deformity. The deformity may be present as a decided displacement backward of the manubrium, so that when the finger is passed along the sternum from above downward there is a sudden, sharp, step-like elevation at the manubrio-gladiolar junction. In other cases there is a marked increase of the normal ridge or angle (angulus Ludovici) which these two portions of the sternum form with each other. No effort should be made to obtain crepitus and abnormal mobility.

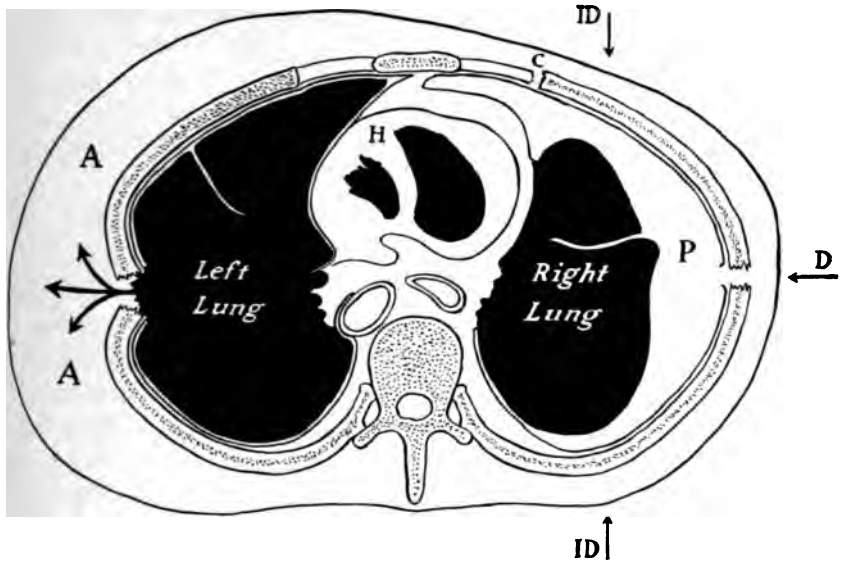

FIG. 142.—CROSS-SECTION OF THORAX (DIAGRAMMATIC) TO SHOW MODE OF PRODUCTION OF PNEUMOTHORAX OR HEMOTHORAX AND OF SUBCUTANEOUS EMPHYSEMA AS A RESULT OF FRACTURES OF THE RIBS.

ID, The arrow accompanying these letters shows the mode of action of indirect force in producing fracture of the ribs; D, mode of action of direct force in producing fracture of the ribs; P, pneumothorax as a result of fracture of the rib and laceration of the pleura on right side; A, extensive subcutaneous emphysema as a result of puncture of a lung by the sharp ends of a fractured rib fragment; the triple arrow shows the mode of egress of the air from the punctured lung into the subcutaneous tissues; H, cross-section of heart; C, fracture at costo-chondral junction without displacement.

Fractures of the sternum may be accompanied by signs of severe intrathoracic or spinal injury, and the symptoms of these may predominate.

INJURIES OF THE THORACIC VISCERA.

These may be divided into two classes:

1. The non-penetrating or subcutaneous.
2. Penetrating.

The first group includes those following the application of a crushing

force, whether applied in a circumscribed manner, such as follows a blow or a fall upon some object, as well as in those where the force acts diffusely, *e. g.*, crushing between two objects, etc.

The second group includes those following the use of sharp or cutting weapons or the use of firearms of whatever nature.

1. NON-PENETRATING OR SUBCUTANEOUS.

The thorax behaves like the skull toward a crushing force, but possesses greater elasticity, so that its contents can alter their volume and form more readily.

Death may follow immediately with symptoms of collapse without visible external signs, probably as the result of the injury of the vagi. Serious injuries are more frequent after crushing of the thorax in younger persons than in older, because the elasticity of the ribs is greater and the ribs offer less resistance. The majority of injuries of this group are accompanied by fractures of the ribs and less frequently by a fracture of the sternum.

FIG. 144. EMPHYSEMA OF SKIN FOLLOWING FRACTURE OF THE RIBS ON THE RIGHT SIDE. Note the puffiness of the face the eyes almost closed (Warren).

Traumatic Asphyxia.—This is a peculiar result of severe thoracic compression (see Fig. 141). It may be recognized by the marked cyanotic discoloration of the head, face, and neck.

The cyanosis terminates very abruptly in the upper portion of the thorax. It is usually accompanied by fractures of the ribs and emphysema, and is due to a dilatation of the cutaneous capillaries of the discolored parts.

Subcutaneous Injuries of the Lungs and Pleura.—The diagnosis of these complications occurring either with or without fractures of the ribs depends on the appearance of the signs of pneumothorax or hemothorax, hemopericardium, pleuritis, emphysema of the subcutaneous tissues, and hemoptysis.

(*a*) *Subcutaneous Injury of the Pleura.*—A moderate degree of emphysema, or of pneumothorax which does not increase, or the presence

of a dry pleuritic friction rub is indicative of an injury of the pleura. If the intercostal or internal mammary arteries are injured, there are evidences of hemothorax.

One can make a probable diagnosis of pleural injury alone from the presence of a slight degree of emphysema and of pneumothorax which rapidly subsides or from the friction sound alone. At times, injuries of the pleura will cause no symptoms. The emphysema can be recog-

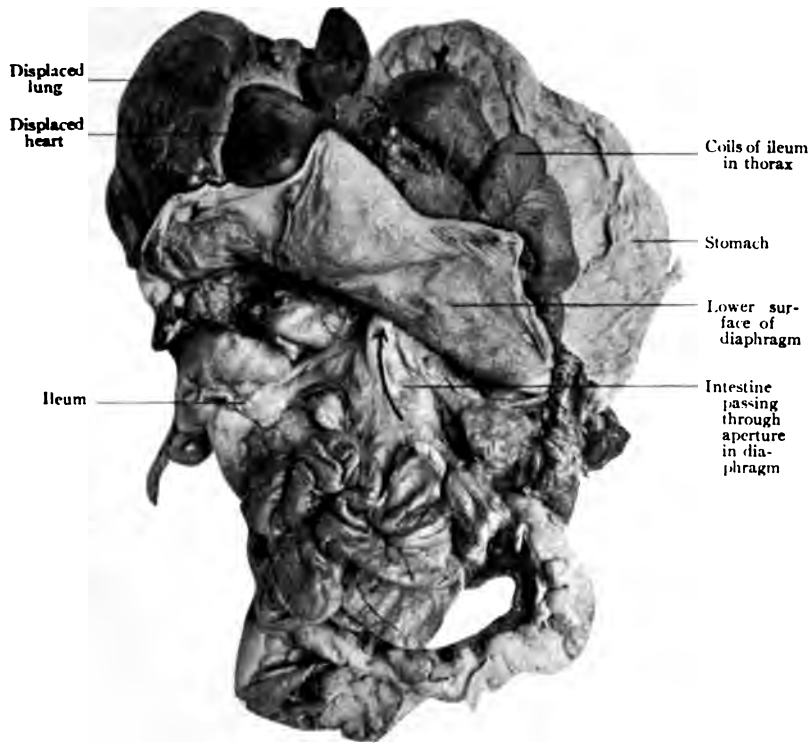

FIG. 144.—VIEW OF DIAPHRAGMATIC HERNIA WITH DIAPHRAGM RAISED IN ORDER TO SHOW HERNIAL OPENING IN DIRECTION OF ARROW.

nized by the peculiar crackling or crepitating sensation obtained upon palpating the skin.

(*b*) *Subcutaneous Injury of the Lungs.*—Subcutaneous injuries of the lungs cause a high degree of emphysema of the skin which rapidly spreads over the entire body (see Fig. 143) and may imperil life. In addition, a pneumothorax results which increases rapidly in degree, crowding the lung and heart over to the opposite side. Rarely it may become bilateral.

Hemothorax and hemoptysis are also characteristic of subcuta-

neous lung injury, varying according to the extent of the same and disappearing gradually.

All of these signs of lung injury may be absent. Bloody sputum is especially apt to be inconstant. A number of cases have been recorded where a pneumonia developed after a subcutaneous injury. It was quite localized, but having all of the clinical characteristics of this disease.

A pulmonary hernia may appear in one of the intercostal spaces

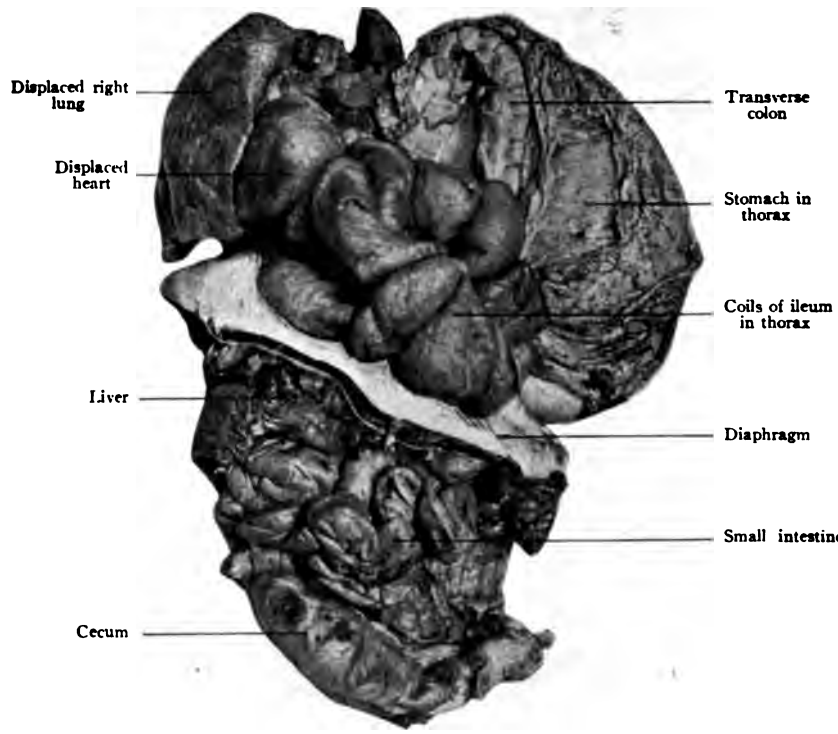

FIG. 145.—ANOTHER VIEW OF DIAPHRAGMATIC HERNIA SHOWN IN FIG. 144 WITH DIAPHRAGM IN POSITION AS FOUND AT AUTOPSY.

as a reducible swelling with a tympanitic note, becoming prominent on expiratory efforts such as coughing. It crepitates distinctly like lung tissue while being reduced.

In the majority of cases the injury to the lung is a complication of fractures of the ribs. Ruptures of the lung may occur without fractures of the ribs. The symptoms are the same in both classes of cases.

(*c*) *Subcutaneous Injuries of the Diaphragm.*—These are seldom recognized during life, being usually immediately fatal. They show

marked displacement (see Figs. 144 and 145) of the thoracic viscera by the abdominal organs, which have escaped through the rent in the diaphragm. There is usually great dyspnea, cyanosis, and a disturbance of cardiac action. In addition, there is a tympanitic note on percussion, bulging of the thorax, and gurgling on the injured side. Vomiting and symptoms of strangulation may also be present. The frequent association of serious abdominal injuries, especially of the parenchymatous organs, such as the liver, spleen and kidneys, with crushing injuries of the bony wall of the thorax or of the thoracic viscera cannot be too strongly emphasized. This association should always be borne in mind in the examination of such a case.

(*d*) *Subcutaneous Injuries of the Pericardium, Heart, Blood-vessels, Esophagus, and Thoracic Duct.*—With the exception of those of the pericardium, these injuries are so rare and so rapidly fatal that they cannot be recognized during life. Injuries of the pericardium without external signs cause either a dry pericarditis or hemopericardium, with the characteristic friction rub of the former, and the increased area of dullness and other physical signs of the latter. In addition, there are always syncope and symptoms of collapse.

Ruptures of the thoracic portion of the esophagus are very rare and can only be recognized by the resultant mediastinitis.

There are nine cases of rupture of the thoracic duct recorded, of which eight were followed by chylothorax.

2. PENETRATING INJURIES OF THE THORAX PROPER.

These may be due to the action of a sharp or cutting weapon or to gunshot wounds, and include chiefly injuries of the lungs and pleuræ. As in the subcutaneous injuries, the cardinal symptoms are subcutaneous emphysema, pneumothorax, and hemothorax. All of these may, however, be absent.

Pneumothorax.—This can be recognized by the usual signs, viz., a tympanitic note on percussion, the absence of respiratory and voice sounds and of vocal fremitus. If it is present upon the left side, there is displacement of the heart to the right.

If the pneumothorax is only moderate in extent and disappears rapidly, it indicates pleural perforation alone (Fig. 143) and is due to the entrance of air through the wounds.

If it increases in spite of the fact that the external wound is closed, it indicates a wound of the lung which has remained open.

Hemothorax.—In every case one must decide whether the hemor-

rhage has occurred from the vessels of the thoracic wall (intercostal and internal mammary arteries) or from the lungs.

(*a*) If from the parietes, the external wound is situated over the internal mammary artery, if the hemorrhage is from this artery. If it is from the intercostal vessels, there is also an external wound to be found bearing some relation to these vessels. In both instances the diagnostic signs are: the escape of blood from the wound in many cases and the presence of a hemothorax.

(*b*) If the hemorrhage is from the lung, there is expectoration of frothy blood and the signs of hemothorax. If the lung is adherent to the chest wall, foamy blood escapes from the wound. Hemoptysis may be absent if the bronchus is plugged or there is no communication of the wound in the lung with a bronchus.

Bilateral hemothorax is usually fatal. Pneumothorax is often combined with hemothorax so that there is a combination of physical signs of the presence of air and liquid in the chest, owing to the fact that the blood almost invariably remains liquid.

3. *Emphysema of the Skin.*—(*a*) If due to a pleural wound alone, it is only moderate in extent, and is due to the entrance of air through the wound and disappears rapidly.

(*b*) If it be due to an injury of the lung, it is far more marked and constantly increases. If the lung is adherent, or if the lung wound is held open by the end of a fractured rib (Fig. 142), the subcutaneous emphysema may become excessive and cause death from asphyxia unless relief is obtained by artificially producing a collapse of the lung.

4. *Dyspnea and Cyanosis.*—These are only marked if there is a high degree of pneumothorax or hemothorax.

5. *Prolapse of lung* through the external wound rarely occurs, but is positive proof of a pleural injury. It is more marked during coughing or expiration.

6. The secondary complications of pleural and pulmonary injuries are *pneumonia* and *empyema*. These are more frequent after penetrating than non-penetrating injuries. The hemorrhagic infiltration of the lungs favors the localization of microörganisms, especially of the pneumococcus.

It is of the utmost importance to bear in mind that penetrating injuries of the thorax are often accompanied by a similar injury of the abdominal viscera. This is especially true of wounds of the right side, the weapon or missile passing through the diaphragm into the liver (Figs. 146 and 147). In the examination of a gunshot or stab wound of the lower part of the thorax, one should always look for signs of abdominal injury,

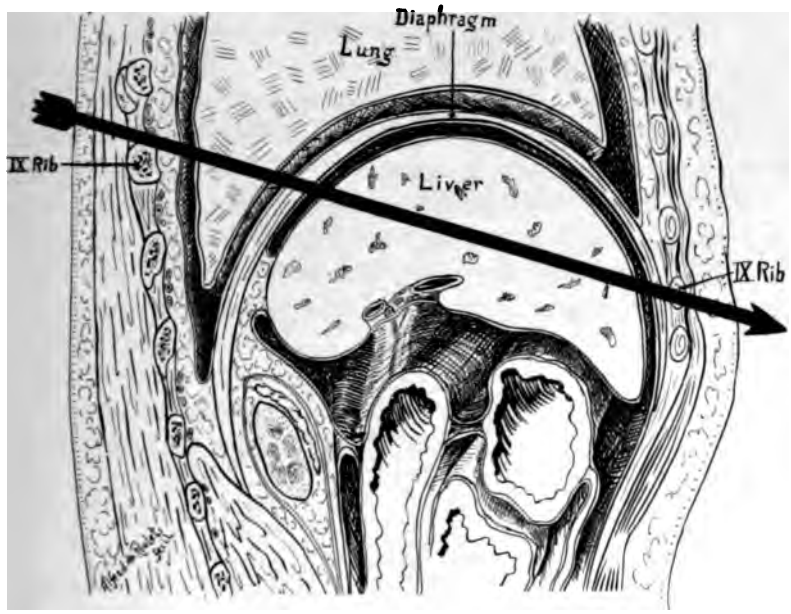

FIG. 146.—COURSE OF BULLET IN CASE OF PENETRATING THORACO ABDOMINAL INJURY.

Wound of entrance beneath angle of scapula in eighth interspace, and wound of exit through ninth rib in mammary line. Bullet passed through pleural cavity, lung, diaphragm and liver

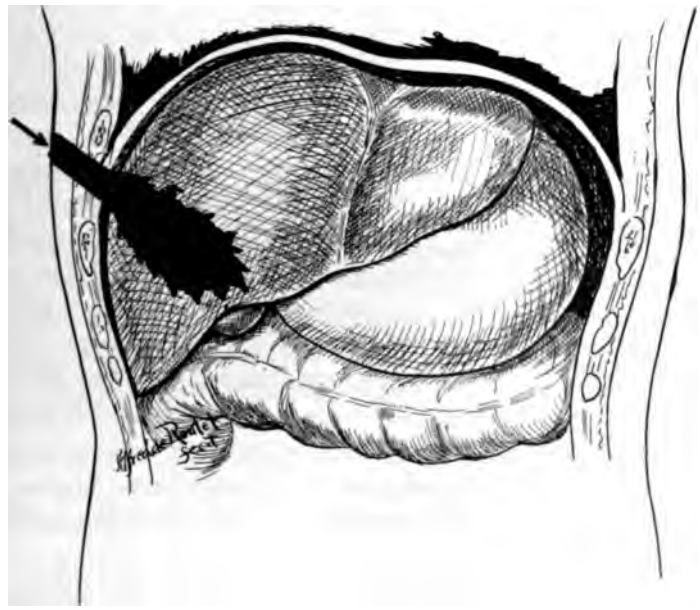

FIG. 147.—GUNSHOT WOUND OF RIGHT LOBE OF LIVER SHOWING EXTENSIVE DESTRUCTION OF LIVER PARENCHYMA AND BLEEDING INTO ABDOMINAL CAVITY.

Same case shown in Fig. 147.

such as muscular rigidity, signs of hemorrhage or of beginning peritonitis, etc.

Penetrating Injuries of the Heart and Pericardium.—Just as in the case of similar injuries of the thoracic cavity proper and of the abdominal cavity, it is impossible to make a diagnosis of the perforation of a viscus, from the position of the external wound alone, although its location over a viscus is of some value. The wound may be at some distance from the heart, as in gunshot wounds.

In the case of injuries of the heart, we place more value upon the accompanying general and local signs.

FIG. 148.—TERTIARY SYPHILITIC ULCERATIONS OF BACK
Note the characteristic sharp edges and punched-out condition of the ulcers, and the tendency to oval or reniform outline.

In the majority of cases there is unconsciousness immediately after the accident, probably due to shock, since the same symptoms appear after injuries of the heart without external wound. Accompanying this primary syncope, and especially to be noticed after consciousness has been restored, are the symptoms of collapse due to internal hemorrhage. The pulse is very feeble and irregular; at times it is scarcely to be felt. There is marked anemia. The local signs of value in diagnosis are those of the accompanying hemopericardium and pneumopericardium. In general, one may speak of three classes of cases:

(*a*) Those associated with a wound in the lung. In these the prominent symptom is pneumopericardium. This may or may not be associated with hemothorax or pneumothorax. The heart sounds are to be heard as if at a distance and there is a tympanitic note replacing the normal area of cardiac dullness. If there is a hemothorax, there are signs of internal hemorrhage and dullness over the lung. In such cases there is considerable anemia, marked collapse, and feeble pulse.

(*b*) Those of the heart alone with escape of blood into the pericardial cavity. These give rise to all of the physical signs of hemopericardium, accompanied by very feeble and irregular pulse, cyanosis, dyspnea, and moderate anemia. The area of cardiac dullness is increased and one hears a splashing sound due to the heart beating in the fluid which surrounds and interferes with its action. This splashing gradually disappears as the pericardial cavity fills up.

(*c*) This third class of cases is characterized by the escape of blood externally through the wound in the chest wall. The blood will be red or blue according to whether the wound is in the right or left heart.[1] In these cases there are marked collapse, signs of hemorrhage (pallor, rapid, very feeble pulse), and irregular heart's action. There is also a slight increase in cardiac dullness and no hemothorax.

The diagnosis of whether the heart has been penetrated or not may be made from considering the location of the wound, the general symptoms, and the physical signs of pneumopericardium or hemopericardium associated or not with those of pneumothorax or hemothorax.

Penetrating Wounds of the Diaphragm.—These are usually associated with gunshot or stab wounds of the thorax and abdomen, and a diagnosis cannot be made until the wound has been explored.

ACUTE AND CHRONIC INFLAMMATORY PROCESSES OF THE THORACIC WALL.

1. OF THE SKIN AND SUBCUTANEOUS TISSUES.

Furuncles are apt to appear on the back of the chest, and may become quite large, especially over the scapulæ, forming large carbuncles which extend quite deeply in the subcutaneous tissues. One must always bear in mind the possibility of diabetes in patients who suffer from these large or recurrent carbuncles.

Acute phlegmon of the subcutaneous tissue of the thoracic wall is quite rare. It may occur by extension from suppuration of the axillary lymph-nodes. The infection travels rapidly in the connective tissue lying between the skin and pectoralis major muscle and in that lying beneath the latter. There is general tenderness, induration, and redness, accompanied by general signs of infection.

Tertiary Syphilis.—One of the favorite seats of gummatous ulcerations is on the skin of the back. They can be recognized by their irregular serpentine form, clear-cut, sharp edges, and deep character. Their

[1] Nietert: "Philadelphia Medical Jour.," Mar. 3, 1902.

FIG. 140.—PRIMARY CARCINOMA OF THE SKIN OF THE THORAX (*T*); *CL*, CARCINOMATOUS LYMPHANGITIS, THE NODULES OF WHICH COULD BE DISTINCTLY PALPATED THROUGH THE SKIN.

multiple occurrence, lack of induration, and the absence of indurated lymph-nodes or lymph-vessels will exclude a carcinoma (see Fig. 149).

Actinomycosis of the skin and subcutaneous tissue of the thorax is always secondary to that of the lungs or mammary glands. In the former case, one finds indefinite symptoms of pulmonary consolidation, with subsequent breaking down of lung tissue associated with multiple areas of softening and sinus formation in the skin. In the variety which is secondary to actinomycosis of the breast, there are also sinuses of long duration leading to the parenchyma and discharging pus. The condition greatly resembles tuberculosis, but there is a more brawny infiltration of the skin, and microscopic examination of the pus shows the presence of actinomyces. Both sarcoma and carcinoma of the skin of the thorax may occur as primary affections (see Fig. 150).

2. AFFECTIONS OF THE BONY THORAX.

Acute Osteomyelitis of the Ribs.—This is a very rare affection of the ribs, especially the form which is due to the organisms producing the same condition elsewhere, viz., the staphylococci. It may occur as a complication of an acute infectious disease, such as influenza, pneumonia, and typhoid, either during the course of the dis-

FIG. 150.—LATERAL VIEW OF PATIENT SHOWN IN FIG. 140, WITH PRIMARY CARCINOMA OF THE SKIN (*T*).

The dotted lines (*CL*) indicate the nodules of a carcinomatous lymphangitis passing toward the axillary lymph nodes which could be distinctly felt through the skin.

ease or following it. It is most frequent at or near the costochondral junction. In the form which follows the above acute infections the diagnosis may be made from the history of the infectious disease, the local findings, and the constitutional disturbances. These two latter are swelling, acute pain, and tenderness over the rib, more or less fever, and high leukocytosis.

Acute Osteomyelitis of the Sternum.—This condition is very rare, only nine cases having been reported. The symptoms are those of violent epigastric pain, high fever, delirium, and local inflammatory symptoms, such as tenderness and edema. The pus may collect in the anterior mediastinum, which is the direction of least resistance; if so, the condition is very apt to be overlooked.

FIG. 151.—TUBERCULOUS ABSCESS OF STERNUM.

Tuberculosis of the Ribs or Sternum.—This form of bone disease is comparatively frequent in the ribs and sternum. Its course is so insidious that the patients often seek surgical advice only when a tuberculous abscess or sinus has formed. It may at times be difficult to determine the point of origin of a tuberculous abscess, owing to the fact that it is apt to gravitate so that its external opening is found at some distance from the original focus (Fig. 154). Upon the back such an abscess may lie beneath the fascia and greatly resemble a lipoma (see Figs. 154 and 155), fluctuation being very indistinct. In the scapular region, tuberculous abscesses both from the posterior ends of the ribs and from the dorsal vertebræ may appear gradually without any inflammatory symptoms or pain. The following are, in general, the diagnostic features of tuberculous affections of the ribs and sternum. The appearance of a thickening of the rib or sternum is accompanied by little pain and by a slight elevation of temperature. In the more advanced stage, in which the cases are usually seen, a soft, fluctuating swelling is found, devoid of inflammatory symptoms and distributed over one or several ribs and their interspaces.

Such tuberculous abscesses must be differentiated from lipomata

and subcutaneous abscesses due to a spontaneously perforated empyema (see page 229). Lipomata are generally lobulated, the skin can be moved over them, and they are freely movable as a whole upon the thorax. They do not fluctuate.

An abscess resulting from a spontaneously perforated empyema occurs oftenest in children and usually around the nipple, but may take place anywhere. There is fever and the physical signs of an effusion into the pleural cavity (see Fig. 161).

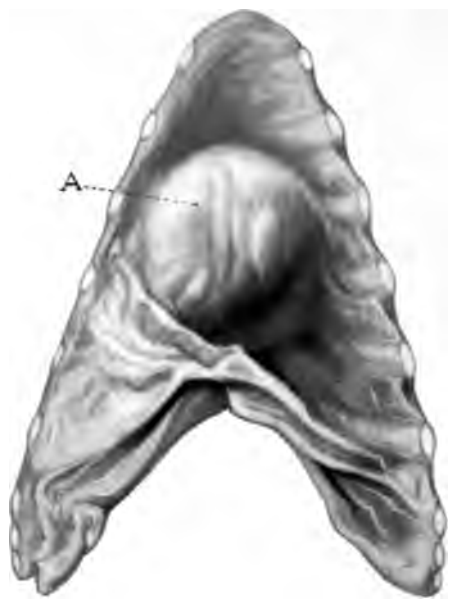

FIG. 152.—POSTERIOR VIEW OF A TUBERCULOUS RETROSTERNAL ABSCESS (A).

FIG. 153.—SAGITTAL SECTION OF STERNUM SHOWING RELATIONS OF THE TUBERCULOUS RETROSTERNAL ABSCESS(A).

When single or multiple sinuses have formed, the diagnosis presents no difficulties. There is a history of a long-continued, almost painless illness, with constant discharge of a thin yellowish pus. The edges of the sinus are lined by flabby or even caseous granulations, and a probe inserted into the sinus leads down to bone denuded of its periosteum.

Tuberculous abscesses may form upon the inner side of the rib as peripleuritic abscesses or collections of pus, and be difficult to differentiate from encapsulated empyema except from the history of an acute infection with high temperature.

In elderly people, a tuberculosis of the rib may begin as a marked enlargement and induration of the rib which greatly resembles a malignant growth, until softening with accompanying fluctuation occurs.

If tuberculosis occurs in the sternum and causes a retrosternal collection of pus (Fig. 152), the pressure symptoms may resemble those of a retrosternal tumor (see page 236) or of an aneurysm, but there is often an edema over the sternum. The pus generally escapes at the left of the sternum at the level of the second rib, but may gravitate downward toward the muscles of the abdomen.

Syphilis.—The form of syphilis of the bones of the thorax which is of the greatest interest is the gumma. It occurs as a flat, often exquisitely sensitive, localized thickening of the periosteum of the ribs and sternum greatly resembling the softer varieties of the periosteal sarcoma. When the process has affected the bone itself, necrosis results and a sinus is present in the skin from which a tenacious and homogeneous pus escapes. At this stage it may be thought to be tuberculosis. In the latter, there is generally a softer fluctuating swelling preceding the formation of the sinus. The pus from a tuberculous abscess is caseous and flocculent and the granulations are flabby and often cheesy. There is also an absence of the history of syphilis, and of the manifestations of syphilis, elsewhere. The latter statement is also true of those periosteal gummata resembling sarcoma of the ribs or sternum, or clavicle (Fig. 156), *i. e.*, before they are broken down. They present more inflammatory symptoms, such as tenderness, etc., than a sarcoma, are slower in growth, and rapidly respond to antisyphilitic treatment.

FIG. 154.—DIRECT POSTERIOR VIEW OF PATIENT SHOWN IN FIG. 155, SHOWING THE EXTENT OF THE TUMOR, DUE TO A TUBERCULOUS ABSCESS, SECONDARY TO DORSAL SPONDYLITIS, AND SIMULATING A LIPOMA.

3. TUMORS OF THE CHEST WALL.

In making a diagnosis of a thoracic swelling which can be either seen or felt externally the following points must be considered:

1. How long has the swelling existed?

2. Does it belong (*a*) to the skin or the bony thorax, or (*b*) arise from within the chest and protrude externally?

3. The consistency and other characteristics, such as rate of growth, etc.

FIG. 155.—LATERAL VIEW OF PATIENT AS SHOWN IN FIG. 154, SUFFERING FROM TUBERCULAR ABSCESS OF SCAPULAR REGION, SIMULATING A LIPOMA.

The dotted line shows the extent of the pseudo-fluctuation.

The various forms of tumors or swellings which may occur are:

1. FROM THE SKIN ITSELF.

Pigmented moles.
Single or multiple soft fibromata.
Sarcoma and carcinoma.
Capillary and cavernous hemangiomata.
Lymphangiomata (capillary, cavernous and cystic).
Lipomata.

2. FROM THE BONY THORAX.

Enchondromata of the ribs or sternum.
Sarcomata of the ribs or sternum.
Secondary carcinomata of the ribs or sternum.
Abscesses due to tuberculous ribs or sternum.

Gummata of the ribs or sternum.

3. FROM WITHIN THE THORAX.
   Aneurysms of the aorta.
   Gravitation abscesses due to dorsal spondylitis.
   Spontaneously perforated empyemata.
   Actinomycotic abscesses.

The characteristics of the swellings due to tuberculous, syphilitic, or actinomycotic infection were considered on pages 218 and 220. All of the tumors in the above list, except the hemangiomata and lymphangiomata, appear after birth. The lymphangiomata and hemangiomata do not differ from the same forms of new-growths elsewhere and have been fully described in the preceding chapter upon the neck. They may at times attain an enormous size, involving one-half of the thorax.

FIG. 156.—PERIOSTEAL SARCOMA INVOLVING FOURTH, FIFTH, SIXTH, SEVENTH, AND EIGHTH RIBS. (Case of Dr. L. A. Greensfelder.)

The arrow points to the prominence caused by the tumor when viewed in an antero-posterior direction.

Pigmented moles can be recognized by their brownish color and occurrence in the skin. They are stationary in growth, until a sarcomatous or carcinomatous change occurs, when they increase in size rapidly, forming very malignant growths (see Fig. 149).

Fibromata also occur in the skin, either as a single pedunculated, often very large tumor, or as a part of a generalized neurofibromatosis (see Figs. 441, 442). They are, as a rule, quite soft, and slow in growth unless a sarcomatous change occurs.

Sarcoma of the skin of the thorax is not frequent. It can be recognized by its rapid growth and more firm consistency than ordinary fibromata.

Lipomata almost always occur in the subcutaneous tissues of the back and sides of the chest. The skin is movable over them and the

tumors show a characteristic lobulation. When deeply situated, they may give rise to a sense of pseudo-fluctuation, resembling that of an abscess. They may grow rapidly at times, giving rise to very large tumors.

The most frequent neoplasms of the bony thorax are **periosteal sarcomata of the ribs.** Sarcomata of the sternum are much rarer. Sarcomata can be recognized by the history of a rapid growth, by their attachment to the ribs, and their firm consistency. They may at times spread over the interspaces to adjacent ribs (Fig. 156). They are seldom attached to the skin, which is usually freely movable over them.

FIG. 157.—CAPILLARY ANGIOMA OF MAMMARY REGION OF INFANT.

Pure **enchondromata** of the ribs are infrequent, but chondrosarcomata are almost as frequent as the pure periosteal variety of sarcoma. They give rise to large and very firm tumors, which enlarge the rib rapidly in all directions. They may grow into the spinal canal and compress the spinal cord.

Secondary tumors of the ribs or sternum are either carcinomata or sarcomata. The diagnosis may be made from the sudden appearance of a growth, whose consistency varies according to the nature of the primary growth. This latter should always be searched for.

Of swellings or tumors arising from within the thorax, the ones of chief interest are **aneurysms** and **pulmonary hernia.** The former can be recognized by the appearance of a prominence over the upper portion of the sternum (see Figs. 158 and 159) or over the second rib which pulsates in the expansile manner, characteristic of aneurysms in general, and which produces a distinct murmur on auscultation. They must be differentiated from those rare abscesses of the sternum or rib which have a transmitted pulsation. Their characteristic situation, the presence of murmurs, expansile pulsation, and the confirmatory *x*-ray examination render a diagnosis easy in the majority of cases.

A pulmonary hernia may appear as an oval swelling in an interspace following a history of injury. It becomes more prominent on coughing, but can be reduced, giving rise to a crackling sound or crepitation. Quite rarely intrathoracic lipomata penetrate the chest wall and appear externally.

EMPYEMA.

Pus in the pleural cavity may be due to a number of causes.

Causes.—(*a*) *It may follow pneumonia.* It is usually due to the pneumococcus, and is called a metapneumonic empyema, but may be the result of a mixed infection by pneumococci and the ordinary pyogenic organisms.

FIG. 158.—SIDE VIEW OF CASE OF ANEURYSM OF THE ARCH OF THE AORTA.

(*b*) *It may occur secondary to other foci of suppuration of the lung or neighboring viscera.* This form is caused by the Streptococcus pyogenes. The infection extends to the pleura either by direct continuity of tissue or by means of the lymphatics. It is in one of these ways that empyema follows an abscess or gangrene of the lung, a subphrenic or hepatic abscess, an appendicitis, a perforation of the esophagus, or a penetrating wound of the thorax. The Streptococcus is often associated with the Staphylococcus aureus. These two, or other organisms such as the typhoid or colon bacillus, may cause an empyema independently.

(*c*) *Tuberculous Empyema.*—This is a variety which is due to the tubercle bacillus, either alone or in conjunction with streptococci or staphylococci.

The **diagnosis** of empyema may be made from:

1. The history.
2. The clinical course.
3. The physical examination and results of exploratory puncture.

History.—There is either an accompanying pneumonia, or the history may show that it followed a pneumonia or a serofibrinous pleurisy or one of the acute infectious diseases, like typhoid, measles, scarlatina, etc. It may also follow some septic pulmonary or abdominal process or there may be the history of a trauma. There may often be a coexisting pulmonary tuberculosis.

Clinical Course.—The symptoms may appear in a slow, insidious, or in an abrupt manner. In the former, there is gradually increasing pallor and emaciation. In the acute onset, the disease often beigns with a chill and great prostration.

After the disease has begun there is a fever of a continuous type in the ordinary purulent form and of an irregular type in the putrid empyemata. In the latter, there are frequent chills and remissions of temperature. There is marked leukocytosis. Repeated profuse sweats are quite characteristic. It was formerly believed that high fever of a more or less continuous type, accompanied by signs of a pleural effusion, suggested an empyema. We now know that a serofibrinous pleuritic exudate may occur with persistently high temperatures, especially in those following influenza.

FIG. 159. FRONT VIEW OF SAME CASE SHOWN IN FIG. 158.

Physical Examination (see Figs. 160 and 161).—*Inspection* shows diminished movement on the side of the effusion. In children there is often bulging of the intercostal spaces. In left-sided empyema the apex-beat is seen to be displaced to the right beyond the right sternal line. In children there is often a lateral curve of the dorsal spine, the convexity being toward the diseased side. In cases of spontaneous perforation of an empyema one sees one or more fluctuating swellings accompanied by the signs of pleuritic effusion. In a recent case seen by the author the above swelling upon the left side showed distinct pulsation.

Palpation.—There is absence of vocal fremitus except in children, where the transmission of the voice sounds is frequently retained. The apex-beat can be felt to be displaced a variable distance to the right in a left-sided empyema.

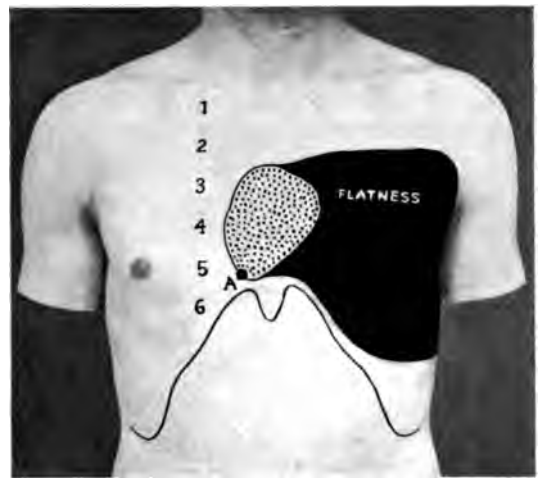

FIG. 160.—AREA OF FLATNESS IN LEFT-SIDED DIFFUSE, THAT IS, NON-ENCAPSULATED, EMPYEMA.

A, Location of apex-beat. The dotted area above it indicates the area of dullness of the displaced heart. The numerals refer to the respective ribs.

Percussion.—If the exudate lies between the two adjacent lobes of a lung (interlobar), or between the base of a lung and the diaphragm (diaphragmatic form), it cannot be recognized by percussion. The area of dullness, or rather flatness (the note being of a wooden quality), may be circumscribed (Fig. 162) or diffuse, according to whether the empyema is encapsulated or not. In the diffuse variety, the upper line of dullness is either S-shaped or flat. The liver and spleen are displaced downwards. In left-sided empyema, the area of cardiac dullness and apex-beat lie upon the right side of the sternum, in many cases.

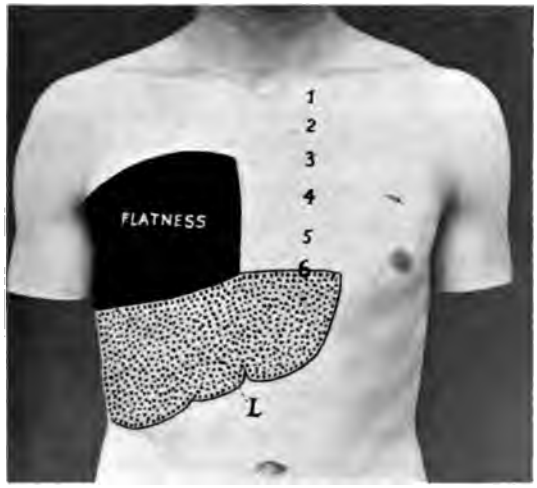

FIG. 161.—AREA OF FLATNESS IN A CASE OF DIFFUSE, NON-ENCAPSULATED, EMPYEMA OF THE RIGHT PLEURAL CAVITY.

L, Area of liver dullness, merging above into the flatness of the empyema. The ribs are indicated on the left side by numerals.

Auscultation.—Over the area of dull-

ness the breath and voice sounds are absent, while above it they are harsh and exaggerated. In children both of these signs are apt to be misleading *because the respiratory and voice sounds are often increased*, even tubular in quality.

Exploratory Puncture.—This method is of great value. The needle should be of medium length and about twice the caliber of an ordinary hypodermic needle. It should be inserted into the center of the area of dullness in an encapsulated empyema. In the diffuse variety it is best introduced in the sixth or seventh interspace in the midaxillary or postaxillary line and the piston gradually withdrawn. If the examination is seen to be negative, when the piston has been withdrawn one-third of the

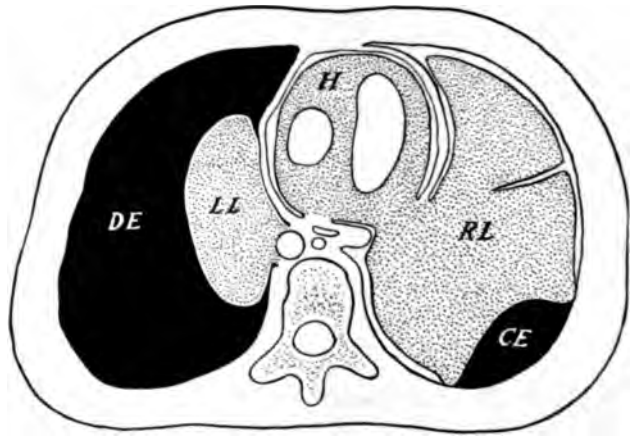

FIG. 162.—LOCATION OF FLUID IN DIFFUSE AND ENCAPSULATED THORACIC EMPYEMATA, AS SEEN IN CROSS-SECTION (DIAGRAMMATIC).

DE, The black area represents the distribution of the pus in a diffuse empyema; *CE*, black area represents the distribution of the pus in an encapsulated empyema; *H*, cross-section of heart; *RL*, right lung; *LL*, left lung (compressed)

way, the needle should be pulled out. One will often find a drop of pus in the tip of the needle when none has been drawn into the barrel of the syringe (Fig. 163).

Differential Diagnosis of Empyema.—(*a*) *From Pneumonia.*—The onset of pneumonia is always sudden, often with a chill. The fever, pulse and respiratory rate are higher, there is more cyanosis and dyspnea, and the sputum is rusty. The dullness is not so wooden in character, there is less resistance, and vocal fremitus is not absent. In some cases, the auscultatory signs, especially in children, may be very confusing. In such patients the voice and respiratory sounds are either plainly to be heard or are even exaggerated. The only way in which such cases, in both

adults and children, can be differentiated from empyema, is by exploratory puncture.

The same holds true for cases of circumscribed dullness in children due to slowly resolving bronchopneumonia with persistent fever, pallor, and sweats.

(*b*) *From Tumors and Hydatids of the Lung and Pleura.*—Both of these give rise to dullness with suppression of respiratory sounds. The percussion note is, however, even flatter than in empyema and there is greater resistance. There is also no fever or sweats and an exudate, if present as the result of the tumor, is serous or hemorrhagic in character.

(*c*) *Hepatic and Right-sided Subphrenic Abscesses.*—These give rise to dullness and absence of voice and respiratory sounds in the lower portion of the pleural cavity. The area of dullness is, however, quite localized (see Fig. 162) or does not extend very high. There is a history of preceding abdominal infection and the liver is displaced downward far more than is the case in an empyema. The septic symptoms are also usually more marked. The pus from a hepatic abscess is chocolate colored; that from an empyema, yellow.

In left-sided subphrenic abscesses the dullness is often most marked at the back of the chest or epigastric region.

An empyema may spontaneously rupture through the pleura and form a subcutaneous fluctuating tumor (see page 226) from the third to the sixth interspace, usually the fifth. When near the heart the swelling may pulsate. The pus may escape along the peripleuritic connective tissue and gravitate toward the abdominal or lumbar muscles, appearing as an abscess in these regions, simulating one due to a spondylitis or a perinephritic abscess.

TUMORS OF THE PLEURA.

Primary sarcomata, endotheliomata, and lipomata are rarely observed in the pleura. Carcinomata and sarcomata are often secondary to the same growths in the ribs, mammary glands, mediastinal lymph-nodes, and lungs. The lipomata may raise from the mediastinal or subpleural fat and project into the pleural cavity.

The diagnosis of tumors of the pleura is very difficult, unless there is a demonstrable primary tumor. The symptoms simulate those of a pleural or pericardial effusion, and are frequently accompanied by more or less exudate, which is hemorrhagic in character, but may be serous. A tumor can be suspected in the presence of the physical

signs of a pleuritic exudate if there is increased resistance when the needle is introduced and by the absence of fever. In the malignant forms of pleural neoplasms there is rapidly increasing cachexia; the effusion, if present, reaccumulates rapidly; and there are often severe intercostal neuralgic pains due to the tumor growing through the intervertebral foramina and compressing the posterior nerve-roots.

FIG. 103.—METHOD OF PERFORMING EXPLORATORY PUNCTURE OF THE PLEURAL CAVITIES.

After careful disinfection of the area of skin through which the puncture is to be made, the needle should be inserted through either the sixth interspace in the anterior midaxillary or posterior axillary lines. This method can be carried out with the patient either lying down or sitting up, preferably the former. Before inserting the needle, the skin should be pressed against the tissues of the interspace, in order to prevent any slipping and striking of the bone with the point of the needle.

PULMONARY ABSCESS, GANGRENE, AND BRONCHIECTASIS.

The intrapulmonary lesions that present themselves to the surgeon for diagnosis may be classified as follows: (*a*) Acute simple abscesses; (*b*) chronic simple abscesses, with or without bronchiectasis; (*c*) acute gangrenous abscesses; and (*d*) chronic putrid abscesses, with bronchiectasis.

Pulmonary Abscess.—The following is usually the history of a

pulmonary abscess: A patient who has had pneumonia, for example, of the lower lobe will have his crisis, the physical signs begin to clear up and the temperature drops.

Suddenly the temperature goes up again, becomes of a remittent type, and the sputum becomes more purulent. There may be a distressing cough, accompanied by the expectoration of foul pus in large quantities. Some elastic fibers may be present in the sputum, but

FIG. 104.—METHOD OF COUNTING THE RIBS FOR THE PURPOSE OF DETERMINING THE LEVEL OF EFFUSION IN THE PLEURAL CAVITY.

One usually begins by palpating the angulus Ludovici or prominence at the junction of the first and second portions of the sternum, that is, of the manubrium and gladiolus. By passing the fingers outward one encounters the second rib. From this point down, the remainder of the ribs can be readily counted.

are rare. There are often paroxysms of coughing, with expectoration of several ounces to a cupful of pus. If the abscess cavities do not communicate with a bronchus, there is but little expectoration. There is in all cases, emaciation, loss of appetite, and a rapid decline in strength. If the abscess becomes chronic, there may be recurrent attacks of fever, with expectoration of pus in large quantities. Physical

examination is rather disappointing. There are few cases in which cavity signs are present. This is due either to the indirect manner in which the abscess communicates with the bronchus, or to the fact that it does not open into one at all. The abscesses following pneumonia are most frequently in the lower lobes, and this is of some aid. There *are no typical physical signs of abscess of the lung* owing to the fact that the cavities (whether due to abscess, gangrene, or bronchiectasis) may be near the surface or quite deeply situated, and may or may not communicate with a bronchus. Dullness, decreased respiratory murmur, vocal resonance, and fremitus are present in the majority of cases, but there may be bronchial breathing. The most valuable sign is the presence of rales—large, moist ones, not infrequently metallic in character. Another striking feature is the variability of the physical signs—once dullness, then a tympanitic note over the same spot. A pus cavity, surrounded by aerated lung tissue and not communicating with a bronchus, gives no auscultatory phenomena. Clubbed fingers develop quite early, as do also symptoms of pressure on the heart, liver and spleen.

Pulmonary Gangrene.—If after a pneumonia, the fever either does not disappear or begins again a few days after a crisis, and the sputum and breath become fetid, and the sputum divides itself into the characteristic three layers, gangrene must be suspected. This, as Fränkel has shown, is a frequent sequel of influenza pneumonia. In the sputum of gangrene one can usually find elastic fibers. The sputum divides into three layers: (*a*) an upper of frothy mucus, (*b*) a middle or clear layer and (*c*) a lower of thick gangrenous detritus. In bronchiectasis following pneumonia the sputum may be fetid at times, but the odor is not so penetrating and there are no elastic fibers. The physical signs of both pulmonary gangrene and bronchiectasis are usually the same as those of abscess.

Bronchiectasis.—In a patient with bronchiectasis there is usually a history of long-continued expectoration, with the sudden expectoration, usually in the morning, of large quantities of foul pus, at times a cupful. This, however, is not characteristic, for the same may be true of chronic simple abscess. There is said to be more mucus in the sputum of a bronchiectasis, but if there are cavities in the lung tissue due to ulcerations of a bronchiectasis there may be just as much pus as in a simple abscess and if there is associated gangrene, just as much fetor as in a gangrene. The frequency of hemoptysis in cases of a gangrene of the lung is due to the fact that the vessels are more apt to pass exposed through the cavity, owing to the more rapid destruction of tissue.

FIG. 165.—ILLUSTRATION OF AREA OF PULMONARY GANGRENE CLOSE TO SURFACE OF LUNG.

Note the greenish color of the wall of the area of pulmonary gangrene and the trabeculæ of surviving lung septa traversing the wall of the cavity.

The previous history of pneumonia, particularly an influenza pneumonia, and the character of the sputum—which in an abscess is of a chocolate color and occasionally contains elastic fibers, and in gangrene becomes more and more offensive as the case progresses—are important points in the establishment of a diagnosis of these two lesions. In bronchiectasis, the sputum is at first odorless, but usually becomes foul from the stagnant pus. The localization of the abscess is always difficult; aspiration is dangerous and the physical signs are not reliable and are often misleading. The *x*-ray is only of confirmatory value, as it shows chiefly thickened areas of lung, and should not be absolutely relied upon. When it shows a shadow at the same point where the physical signs are present, it is of value. The *x*-ray may mislead one as to the seat of the abscess, and is of no service in distinguishing between single and multiple foci or between abscess, gangrene or bronchiectasis.

ECHINOCOCCUS OF THE LUNGS.

This localization of the echinococcus is next in frequency to that of the liver and occurs oftenest in the right lower lobe. Clinically it greatly resembles a pleuritic effusion, and a differentiation can only be made by an examination of the fluid obtained by exploratory puncture. In the case of echinococcus it is clear, watery, and contains the characteristic hooklets of the worm.

Only large cysts or a collection of smaller ones produce any symptoms. These cause dullness which is more irregular than that of an effusion. There are signs of pressure, such as dyspnea, displacement of the heart and liver, and pain, especially upon lying on the diseased side. There is often enlargement of the cutaneous veins over the cyst and widening of the intercostal spaces.

There is no rise in temperature unless the cyst is infected and has ruptured. Then the signs greatly resemble those of an abscess in the lower lobes.

ACTINOMYCOSIS OF THE LUNGS AND PLEURA.

This disease may appear clinically in one of two forms:

(*a*) A peribronchial pneumonic form in which the symptoms resemble those of tuberculosis. In this form, the prominent symptoms are hemoptysis, fever, loss of weight and strength, and mucopurulent expectoration. The diagnosis can only be made if the ray fungus is found in the sputum.

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(*b*) A second clinical form in which the disease has extended into the pleural cavity and chest wall. The signs are either those of a dry pleurisy or there is a board-like infiltration of the chest wall, followed by the appearance of subcutaneous abscesses. The spontaneous perforation of the latter leaves sinuses which may be confused with those of tuberculosis. The finding of the ray fungus will clear up the diagnosis.

TUMORS OF THE LUNGS.

Tumors of the lungs are almost always malignant, and rarely primary.

Secondary growths, *e. g.*, sarcomata and carcinomata, are usually disseminated over both lungs, while primary ones, *e. g.*, endothelioma of the pleura, carcinoma arising from the bronchial tubes or sarcoma of the mediastinum extending into the lung, occupy the greater part of one lung. The diagnosis of the presence of secondary tumors depends upon (*a*) the appearance of pleuritic pain; (*b*) cyanosis; (*c*) dyspnea; (*d*) cough, and (*e*) the signs of effusion following a year or more after a primary tumor of the breast, limbs, etc., has been diagnosed as such. A primary growth of the lungs shows unilateral involvement with signs of consolidation, but the tactile fremitus is absent and the breath sounds are diminished in intensity. There is usually prune-juice expectoration, emaciation, enlargement of the adjacent cervical lymph-nodes, signs of pleuritic effusion, and an afebrile cough.

SUPPURATIVE PERICARDITIS (PYOPERICARDIUM).

Both serous and purulent pericardial exudates, as is the case in the pleural cavity, give rise to the same physical signs.

Purulent pericarditis may (*a*) be pyemic in origin, or (*b*) follow a penetrating wound of the pericardium, or (*c*) arise by extension from a neighboring focus, or (*d*) be the result of one of the acute infectious diseases.

Perforation of the thoracic wall may occur, giving rise to sinuses or abscesses.

Purulent pericarditis occurring during the course of a septicopyemia cannot be recognized except from the physical signs, or if attention has been called to the heart by the accelerated, feeble, and often irregular pulse.

In the other varieties there are usually repeated chills accompanied by high fever and sweats. The pulse and respiratory rate are rapid.

INFLAMMATORY PROCESSES IN THE MEDIASTINUM (MEDIASTINITIS).

These may be either acute or chronic. The former are caused by the ordinary pyogenic organisms and arise by extension of suppurative processes in the neck or rarely from an acute osteomyelitis of the ribs or sternum. From the neck, pus may reach the mediastinum either along the carotid sheath or along the previsceral or retrovisceral spaces. (See page 170.) The symptoms of acute mediastinitis are severe pain and a feeling of oppression behind the sternum radiating to the shoulders. This is accompanied by fever, chills, sweats, rapid pulse, and other signs of a septic infection. The diagnosis may be made from these symptoms, taken in conjunction with the history of a preceding infection in the adjacent parts, *e. g.*, neck, retropharyngeal structures, etc.

Chronic inflammatory processes are almost always due to tuberculous disease of the bronchial lymph-nodes or to tuberculosis of the sternum (Fig. 151) and are impossible to recognize unless they rupture into the bronchus, aorta, or œsophagus.

TUMORS OF THE MEDIASTINUM.

All forms of tumors of the mediastinum cause somewhat similar symptoms. Their severity depends upon the size and nature of the growth.

The most frequent conditions which thus appear with signs of intrathoracic pressure are the following:

Benign Affections.	Malignant Affections.
1. Retrosternal goiter.	1. Carcinomata arising in the lymph-nodes or peribronchial tissues.
2. Dermoid cysts.	2. Primary lymphosarcomata, or endotheliomata.
3. Echinococcus cysts.	3. Hodgkin's disease (Pseudoleukemia).
4. Aneurysms of the arch of the aorta.	
5. Fibroma.	

The diagnosis in the case of the malignant affections depends (*a*) upon the greater rapidity with which the symptoms of pressure appear, (*b*) the more frequent association of pleuritic effusion, and (*c*) in many cases the history of primary growths situated elsewhere in the body.

The symptoms of mediastinal tumors are:

1. Engorged veins on the anterior and lateral portions of the thorax, sometimes accompanied by cyanosis and edema of the skin (see Fig. 167).

2. A marked dyspnea, associated often with a harsh, brassy cough and pain.

3. Symptoms of pressure on the recurrent laryngeal nerves causing abductor paralysis of one or both vocal cords, usually the left.

4. Dysphagia due to pressure on the esophagus.

5. Dullness over the upper portion of the sternum or adjacent portions of the thorax (Fig. 167).

6. Rarely the *x*-ray shows a distinct shadow.

7. The heart and lungs may be displaced.

8. There may be a bulging of the sternum which may or may not pulsate. If it does, it has the forcible expansile pulsation of an aneurysm (Fig. 158).

9. Palpitation of the suprasternal notch and of the deep cervical nodes may confirm the suspicion of a tumor. This is especially true of a retrosternal goiter, which moves upward during the act of swallowing.

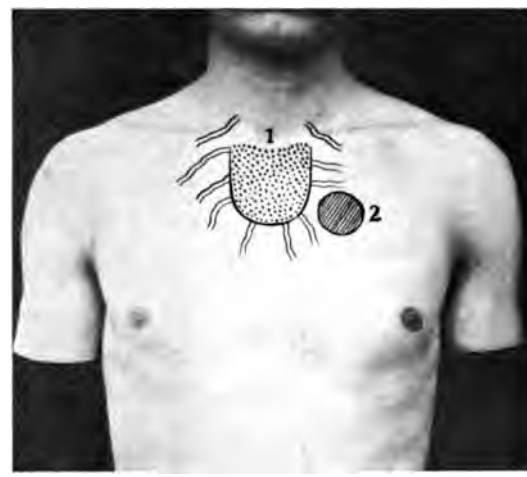

FIG. 167.—LOCATION OF AREA OF DULLNESS IN MEDIASTINAL TUMOR AND OF PROMINENCE IN ANEURYSM OF THE ASCENDING ARCH OF THE AORTA.

1, Area of dullness over manubrium in a case of sarcoma of the mediastinum. The outlines running toward it represent the dilated veins of the skin of the thorax. 2, This figure is placed to the left of the most frequent seat of prominence due to aneurysm of the ascending portion of the arch of the aorta.

When an aneurysm has not eroded the chest wall it may be almost impossible to differentiate from a tumor. The cyanosis and venous enlargement are more marked in tumor and these symptoms are more progressive. The most valuable signs of aneurysm are the thrill to be felt and the bruit often heard over the sac, and the radiating pains to the arms and neck. The other signs of aneurysm are hoarseness from recurrent laryngeal pressure, dyspnea, and dysphagia.

Dermoid or echinococcus cysts may occasionally be recognized by finding hairs or hooklets respectively in the sputum. A case of dermoid cyst has been reported by the late Nicholas Senn in which the diagnosis was made by finding hair in the sputum.

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FOREIGN BODIES IN THE AIR PASSAGES.

The diagnosis of foreign bodies in the larynx, trachea, or bronchi depends (*a*) upon the history, (*b*) upon the appearance of certain symptoms of disturbances in function, and (*c*) the results of examination with the *x*-ray (Fig. 103), the laryngoscope, and the bronchoscope.

In the majority of cases there is a history of the aspiration during an inspiratory effort of one of four varieties of foreign bodies.

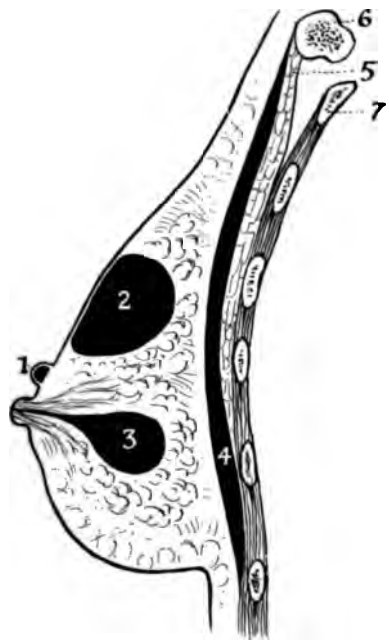

FIG. 108.—SEATS OF VARIOUS FORMS OF SUPPURATION IN MASTITIS.

1. In subcutaneous abscess of areola; 2, large parenchymatous abscess approaching surface of breast; 3, seat of suppuration in early stages of ordinary parenchymatous mastitis, showing how infection is transmitted from nipple along milk ducts; 4, retromammary abscess, lying between breast and pectoralis major muscle; 6, cross-section of clavicle; 7, cross-section of first rib (modified from Duplay).

(*a*) Round or conical bodies—*e. g.*, coins, buttons, tin whistles, and bullets.

(*b*) Sharp bodies, as pins, needles, tacks, and splinters.

(*c*) Vegetable substances which swell, such as seeds or beans.

(*d*) Vegetable substances which do not swell, as wheat, etc.

The symptoms vary greatly. In some cases there are frequent attacks of asphyxia. This the case with the first group, especially in the initial period. In other cases, these attacks of suffocation may be absent. If the body lodges in the right bronchus, as is most often the case, there is a diminution or even complete loss of respiratory sounds and movements on the same side, and such cases have been erroneously diagnosed as pulmonary abscess, tuberculosis, etc. Over the point of its arrest, sibilant and sonorous rales may at times be heard. Sharp bodies cause localized pain, while larger obstructing bodies cause a sense of pressure. Cough is quite frequently present and the expectoration may be bloody from erosion of the bronchi.

After noting the history and the symptoms an examination should be conducted with the laryngoscope. If this results negatively an *x*-ray picture is taken. If the latter is also negative the patient should be anesthetized and the Killian bronchoscope employed to find the foreign bodies.

In the absence of a history one must at times suspect the presence of a foreign body from the symptoms of a circumscribed broncho-

breast becomes extremely tender to the touch and the severe pain radiates toward the axilla.

In the early stages there are distinctly indurated and usually multiple areas to be felt in the breast, which can be distinguished from the nodules due to stagnation of milk, or so-called "caking of the breast," by the more severe inflammatory symptoms, such as pain, fever, redness, etc.

Another point of differentiation is the fact that proper support will be followed by the speedy disappearance of symptoms in the "caked" breast, while in a true mastitis they persist and increase in severity.

FIG. 170.—METHOD OF PALPATING A CYSTIC TUMOR OF THE BREAST.

In puerperal mastitis, in addition to the symptoms of severe pain in the breast, induration and rise of temperature, there is a painful enlargement of the pectoral and axillary lymph-nodes (Fig. 169). After a few days of the above symptoms, the indurated areas become larger and approach the overlying skin. This becomes red and tender, and soon evidences of fluctuation can be obtained, showing that abscess formation has occurred. If, after one of these foci has been opened, the temperature persists, abscesses must be present elsewhere in the breast with retention of pus.

There are cases of puerperal mastitis in which a discharge of pus continues from multiple foci, months after the abscesses have been opened. These are the result of a venous congestion due to allowing the breast to sag, by not being sufficiently compressed and supported.

The retromammary form of acute mastitis is not frequent. It can be recognized by the absence of foci in the areola or parenchyma, and the presence of a marked swelling along the periphery of the breast,

accompanied by pain and high fever. Fluctuation appears at the lower margin of the breast. At times chronic retromammary abscesses are met with, due to tuberculosis of the ribs or breast.

2. **Mastitis Neonatorum.**—During the second to fourth week after birth painful enlargement of the breast occurs in both male and female infants. The breast enlarges to the size of a walnut, is quite hard and tender. This enlargement generally disappears within a short time, but may occasionally advance to suppuration, giving rise to redness of the surface and fluctuation.

3. **Traumatic Mastitis.**—After a blow or fall upon the breast of non-pregnant women the organ becomes enlarged, quite painful, and may be accompanied by slight rise of temperature. The diagnosis may be made from the history, the local tenderness, and the frequent general enlargement and palpation of tender indurated areas in the parenchyma.

FIG. 171.—PALPATION OF SUPRACLAVICULAR LYMPH-NODES IN THE FEMALE, IN CASE OF SUSPECTED CARCINOMA OF THE BREAST.

4. **Chronic Cystic Mastitis.**—This condition is one which has been described by various writers under different names. Koenig has called it "chronic cystic mastitis"; Reclus describes it as "maladie cystique"; Virchow, as "diffuse fibroma"; others have termed it "chronic interstitial mastitis"; and, finally, the term "diffuse fibroadenoma" has been given to it.

From a pathologic standpoint[1] there are three types:

1. A low grade of inflammation with desquamation of the glandular epithelium and the formation of multiple smooth-walled cysts. This is the form described by Koenig as a chronic cystic mastitis.

[1] Curtis and Wood: "Medical News," August 13, 1904.

2. Those of a more adenomatous type described by Schimmelbusch and Reclus.

3. Transition cases. In these the breast may show a diffuse fibro-adenomatous condition, but in certain areas a malignant change, *i. e.*, to carcinoma, has taken place. In thirty cases examined microscopically by Greenough[1] such a malignant change had occurred in three. In some cases there is a marked tendency to papillomatous in-growths into the lumen of the dilated acini or cysts. These cases have a special tendency to become malignant.

FIG. 172.—PALPATION OF AXILLARY LYMPH-NODES IN THE FEMALE.

This condition occurs predominantly in women who have borne children, but not nursed them, and is especially frequent just before the menopause. It may, however, occur in nulliparæ. In some cases there is an apparent exacerbation at the time of menstruation, new nodules appearing and the breasts becoming painful. The condition subsides rapidly in the menstrual intervals. Clinically, one can feel a number of flat, firm leathery nodules in one or both breasts, which may be quite sensitive. The patients will often state that the nodules become painfull during the menses, accompanied by a transitory enlargement of the axillary and pectoral lymph-nodes (Figs. 169 and 172).

If a cyst of any size is present, it feels tense and elastic. If a number of smaller cysts have been formed they feel like beans or shot (Curtis). The principal affection from which it must be differentiated is carcinoma.

This question is especially apt to arise if one or more large cysts

[1] Greenough and Hartwell: "Journal of Medical Research," June, 1903.

have formed. The condition can be, however, distinguished from carcinoma by the following features:

1. Chronic mastitis is usually bilateral, or if not, there are many nodules in a single breast which are frequently quite tender.

2. The nodules, if cystic, have a distinct smooth, rounded form, and unless very tense show fluctuation.

3. The size and tenderness of the nodules often increase during menstruation.

4. The axillary nodes, rarely enlarged, are soft and tender.

5. The progress of the disease extends over years, unless large cysts are present.

There are a few exceptions; for example:

1. Cases in which there is marked induration and sharp demarcation.

2. Cases in which carcinomatous changes have already occurred (transition cases), either in one of the breast nodules or in the axillary nodes alone.

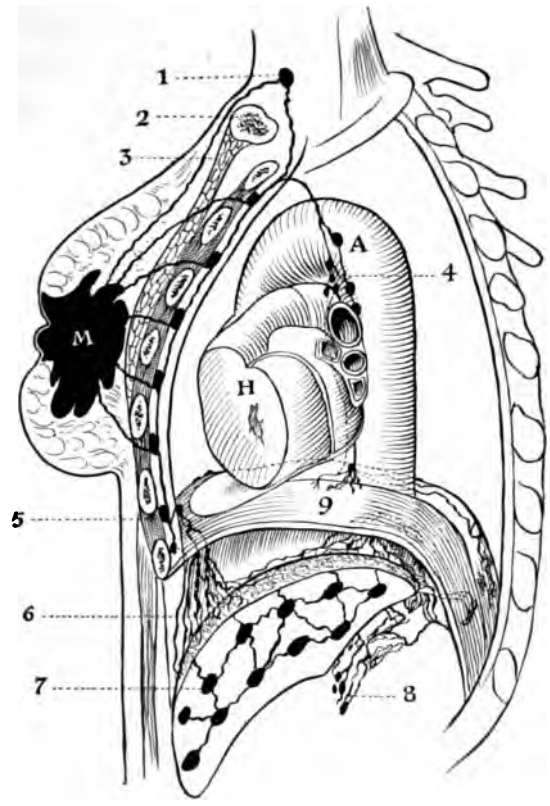

FIG. 173.—RELATION BETWEEN LYMPHATICS OF FEMALE BREAST AND THOSE OF MEDIASTINUM AND LIVER.

M, Carcinoma of breast, causing retraction of nipple; 1, lymph-nodes of supraclavicular fossa; 2, cross-section of clavicle; 3 pectoralis major muscle; 5, lymph-nodes along the internal mammary artery; A, aorta; 4, lymph-nodes at bifurcation of trachea; these may cause dyspnea and cough after carcinoma of breast; H, heart, seen in section; 6, lymphatics of upper surface of liver, which receive the lymph from the mediastinal nodes through the diaphragm; 7, metastatic foci in the liver; 8, lymph-nodes at porta hepatis; 9, lymph-nodes, along aorta. (Modified from Kuttner and Duplay.)

In such cases it is absolutely impossible to differentiate between a chronic cystic mastitis and carcinoma until marked retraction and fixation of the nipple and marked induration of the tumor and of the axillary nodes have occurred. If any doubt exists, it is advisable to operate and submit a portion of the suspicious area to a pathologist for microscopic examination.

TUBERCULOSIS OF THE BREAST.

Of 100 reported cases of this rare condition, only 65 have been examined microscopically. It involves the gland most frequently at the period of life (twenty to forty) of its greatest activity. The course is a very chronic one. It either occurs in (*a*) a nodular form; (*b*) as a cold abscess; (*c*) confluent form (most common); (*d*) miliary form.

The diagnosis is rarely made before either an abscess has formed or sinuses exist. Usually the case is supposed to be a fibroadenoma in the nodular form or is diagnosed as a chronic cystic mastitis (especially in the more confluent form) before operation. Sinuses, if they exist, have the typical bluish undermined edges of tuberculous lesions.

Early Axillary Node in a Case of Carcinoma of the Breast.

The arrow points downward toward the retracted nipple.

In many cases the axillary lymph-nodes are enlarged, but if these are absent the diagnosis may be very difficult.

Simple cysts resulting from chronic mastitis are more circumscribed, fluctuate much sooner, are often painless, and do not enlarge the axillary nodes. When the cysts are small and tender, the differentiation is very difficult. In tuberculosis there is, however, early axillary lymph-node enlargement.

From the scirrhus form of carcinoma this condition can be distinguished by the fact that tuberculosis occurs in younger persons, is never as indurated, and there are more apt to be multiple nodules.

From actinomycosis it can be distinguished by finding the ray in the yellow granules and by the thickened indurated skin.

SYPHILIS OF THE BREAST.

Gummata may occur in any part of the breast.[1] One should always suspect syphilis when there is the history of one or more swellings which have disappeared spontaneously or after the administration of iodids and mercury. Gummatous tumors are free early in their course, and develop slowly and painlessly. They ulcerate and break down much earlier than cancerous nodules. They do not retract the nipple and seldom cause enlargement of the axillary lymph-nodes. The diagnosis is aided by the treatment and the history of syphilis.

SIMPLE HYPERTROPHY OF THE BREASTS.

This condition can be readily recognized, owing to the enormous, often bilateral, increase in the size of the breasts. It occurs most frequently at puberty or during pregnancy. It may be simulated by a retromammary lipoma, but this is only unilateral. The breast may increase so rapidly in size that within a year it increases ten to twenty pounds, or even more, in weight, and extends down as far as the knees.

A hyperplasia of the male breast occurs on either one or both sides, and causes pain and discomfort.

SIMPLE NEOPLASMS OF THE BREAST.

These are best divided into two great classes, the benign and the malignant. To the former belong the fibroadenoma, with its special forms, the fibroma intracanaliculare, and the papillary form.

To the second or malignant group belong the sarcoma and carcinoma.

BENIGN NEOPLASMS.

Fibroadenoma of the Breast.—Pure fibromata and pure adenomata are very rare. The majority of these tumors contain both forms of tissue, but usually more of the fibrous than of the glandular form.

The first form, known as an intracanalicular myxoma, and often called fibroma intracanaliculare, occurs between the ages of twelve and thirty. It forms multiple, bilateral, firm and freely movable tumors of irregular outline which are elastic and semifluctuant on palpation. On section they are white and glistening and microscopically are composed of spaces or clefts lined by epithelium with many ingrowths into the spaces. They are slow in growth and usually quite painless.

[1] J. B. Bissell, "Medical Record," July 6, 1907.

The chief diagnostic points, then, are:

(*a*) Age. They generally occur between twelve and thirty.

(*b*) Growth. As a rule, the increase in size is very slow and gradual. In some cases they remain dormant for many years, and then suddenly increase in size. Apparent recurrence may take place, but these are undoubtedly new tumors.

(*c*) Mobility, consistency, and form. They are usually quite firm and round, or oval. The larger they grow, the softer do they become. The nearer the skin they lie, the more movable are they. As a rule, they are not painful and are never as hard as a carcinoma. When removed, they are found to be distinctly encapsulated.

FIG. 175.—ANTERIOR VIEW OF CASE OF SARCOMA OF THE BREAST

Note the enormous enlargement of the right breast (*S*), and the large tumor of the axilla (*AL*), due to secondary enlargement of the axillary lymph-nodes.

(*d*) They never cause retraction of the nipple or enlargement of the axillary lymph-nodes.

The second form or adenofibroma proper occurs less frequently than the intracanalicular variety. The tumors are smooth and not nodulated as in the intracanalicular variety. They are quite firm and elastic.

MALIGNANT NEOPLASMS.

Sarcoma of the Breast.—These constitute about 2 to 8 per cent. of all breast tumors and are usually of the round-celled type. In 80 per cent. of the cases they develop from the intracanalicular myxomata (see page 245). They occur before the age of thirty, and are characterized by their rapid growth and the early ulceration of the overlying skin. The entire breast is usually involved, causing it to feel uniformly firm. Enlargement of the axillary lymph-nodes is not frequent, but when present the secondary tumor attains enormous size (Fig. 175).

Carcinoma of the Breast.—The best division of this form of neoplasm from a clinical point of view is into a scirrhus or hard variety, and

a medullary or softer variety. In the scirrhus form the connective tissue predominates, while in the medullary form the epithelial elements exceed the stroma in amount. There is a variety known as carcinoma simplex which stands midway between the scirrhus and medullary. Colloid carcinoma may occur, but is relatively rare and cannot be diagnosed as such, before operation. The chief diagnostic points of carcinoma of the breast are:

(*a*) *Age.*—The medullary form usually occurs in women between thirty-five and fifty-five, while the scirrhus variety occurs after the latter age. Carcinoma more frequently affects the breast of women who have nursed children, or have had infections or chronic cystic mastitis (page 241). There is undoubtedly a direct relation between cancer of the breast and trauma.

FIG. 176.—EDEMA OF THE RIGHT ARM DUE TO COMPRESSION OF AXILLARY VEINS, TWO YEARS AFTER OPERATION FOR CARCINOMA OF THE BREAST.

Note the great difference in size between the right and left arms.

(*b*) *Location and Growth.*—The disease usually begins as a single nodule, most frequently in the upper outer quadrants and central portions of the breasts. If the carcinoma begins in the ducts instead of the acini, there is early fixation and induration round the nipple.

This duct or tubular form of carcinoma is the one usually found in the male. It is less frequent than the deeper acinous form in the female breast.

The carcinomatous nodule is usually single.

The rate of growth is far more rapid than in the case of benign tumors. In the medullary form this rapidity of growth is more marked than in the scirrhus form.

(*c*) *Mobility, Consistency, and* [redacted]—In the early stages, the tumor

is hard and somewhat movable. It soon becomes adherent to the skin (especially around the nipple in the scirrhus form) and to the underlying pectoral muscle (Fig. 174). In the medullary form, the tumor is much softer than in the scirrhus form. Ulceration of the overlying skin may occur at an early stage. At first the tumor is more or less rounded and can be distinctly outlined. Later it becomes nodulated and diffuse.

(*d*) *Condition of the Nipple and Regional Lymph-nodes.*—In the scirrhus more frequently than in the medullary form the nipple is both fixed and retracted. Ulceration may occur quite early at this point (Fig. 174). Pain is, at times, an early and marked symptom in carcinoma.

There is early enlargement of the axillary in 84 per cent. of the cases and less often of the supraclavicular lymph-nodes (about 10 per cent.) (Figs. 171 and 172).

A systematic examination of these regions, as well as of the liver, if palpable, should be made (Figs. 171 and 175) for evidence of lymph-node and visceral metastases. The carcinomatous lymph-nodes are very hard and often adherent to each other.

(*e*) *Complications.*—In addition to the early cachexia, cancer of the breast may produce metastases in the following places:

1. In the mediastinal lymph-nodes, causing cough and dyspnea (see Fig. 173).

2. In the lymphatics of the skin of the breast.

The skin of the entire front of the chest has a board-like consistency and has been called "cancer encuirasse" (armor-like cancer).

3. Metastases in the lungs, liver, pleura, and brain.

4. Osseous metastases. If in the long bones, spontaneous fractures may occur after the most trivial injury. If the deposit occurs in the spine or skull, symptoms of pressure upon the spinal cord or brain occur in cases where there has been no suspicion of a metastasis. A so-called *paraplegia dolorosa* is quite characteristic.

5. *Edema of the hand* (Fig. 176) from pressure of carcinomatous lymph-nodes on the axillary vessels.

DIFFERENTIAL DIAGNOSIS OF TUMORS OF THE BREAST.

	Chronic Cystic Mastitis.	Fibroadenoma.	Carcinoma.
Age	Usually before forty, but may occur before menopause, often more painful and larger during menses.	In young women.	Generally over forty, rarely before that age; accompanied by cachexia.
Location and growth	Multiple nodules in one or both breasts. Very slow growth, except in large cysts.	Anywhere. Grow very slowly.	Usually in inner quadrants. Grow rapidly.

DIFFERENTIAL DIAGNOSIS OF TUMORS OF THE BREAST.—(*Continued.*)

	Chronic Cystic Mastitis.	Fibroadenoma.	Carcinoma.
Mobility.....	Not movable in breast unless one or more large cysts—then only moderate mobility.	Freely movable.	Movable in very earliest stage; later adherent to skin or pectoral muscle and fixed in breast.
Consistency and form.....	Large cysts either are round and fluctuate or are elastic. Smaller multiple nodules feel like beans.	Not as hard as carcinoma; outline rounded and sharp.	Very hard, irregular, and not demarcated.
Condition of nipple, and pain..... ...	Very rarely retracted. Tumors often painful, especially at menses.	No change. No pain, as a rule.	Early retraction. Often pain, quite severe and early.
Condition of axillary lymph-nodes and metastases.....	Earlier enlargement than in cancer. Tender and soft. Often more painful during menses.	Not enlarged, as a rule.	Early enlargement. Induration very marked. Evidence of metastases (see page 248).

DISEASES OF THE MALE BREAST.

Of the inflammatory affections of the adult male breast, only chronic mastitis need be mentioned. A syphilitic enlargement may at times occur, and can be readily diagnosed from the history of the case, by the rarity of other benign enlargements of the male breast, and by the rapid improvement under anti-luetic treatment. Of neoplasms, fibroadenoma, sarcoma, and carcinoma can occur. The first-named occurs in very young adults; the enlargement is soft, of very slow growth, and does not cause pain or axillary lymph-node enlargement. Of all breast neoplasms, 99 per cent. occur in women and only 1 per cent. in men. Both sarcoma and carcinoma differ but little clinically from the same conditions in women. In sarcoma the tumor is relatively soft, grows rapidly, and does not so often cause enlargement of the axillary lymph-nodes as does a carcinoma. The latter causes a firm indurated mass in the male breast with early retraction of the nipple and early enlargement and induration of the axillary lymph-nodes.

CHAPTER IV.

THE ABDOMEN.

AFFECTIONS OF THE ABDOMINAL WALL.

INFLAMMATORY PROCESSES.

Furuncles of the skin of the abdomen do not differ from those found elsewhere. It is interesting to note that they cause early enlargement of the inguinal lymph-nodes which rapidly disappears as soon as the furuncle is incised and drained.

Subcutaneous and intramuscular suppuration is usually secondary to an infected wound or to some more deeply seated infective process. There is more or less induration, so that it is difficult to detect fluctuation. There is also superficial pain, redness, fever, and enlargement of the inguinal lymph-nodes. The area of suppuration may either remain within the various tissues composing the abdominal wall or the pus may escape externally and a sinus remain. The diagnosis of the source of the pus escaping from such a sinus can only be made by a process of exclusion. A careful examination should be made of the entire trunk, the various causes mentioned below being eliminated, one after the other.

In the abdominal wall proper, suppuration may occur in a number of distinct spaces.

1. *Within the sheath of the recti muscles* following typhoid, or, rarely, an injury. The pus can only spread as far as the umbilicus, where it may perforate. The previous history, the location of the swelling, pain, and other inflammatory signs render a diagnosis easy. The swelling is more prominent when the patient lies down.

2. *Retromuscular Suppuration.*—The pus lies in the loose connective tissue between the individual muscle layers or between the transversalis fascia and peritoneum. All of these spaces communicate with each other freely and also with the connective tissue of the pelvis, iliac fossæ, and retroperitoneal space. A special space, known as the prevesical or cavum retzii, is often spoken of as being separated from the retromuscular space by a septum (see Fig. 177), but such a division is not found clinically, pus in one of these spaces spreading by direct continuity to any of the others. With the exception of the rare cases of idiopathic suppuration in the prevesical space, the majority of the cases

of suppuration in the intermuscular and retromuscular spaces are secondary. They may be due to a number of different primary causes, which it is well to remember in making a diagnosis.

Sources of Suppuration in the Abdominal Wall and of Abdominal Sinuses.—(*a*) If prevesical, to cystitis or diseases of the prostate or seminal vesicles.

(*b*) If around the kidney, it is the result of an infection of the perinephritic tissue following some renal infection or a perinephritis.

(*c*) If in the retroperitoneal connective tissue of the iliac fossa it may be due (*a*) to suppuration of the deep iliac lymph-nodes following phlegmon of the thigh or an inguinal adenitis; (*β*) to tuberculosis or osteomyelitis of the pelvic bones.

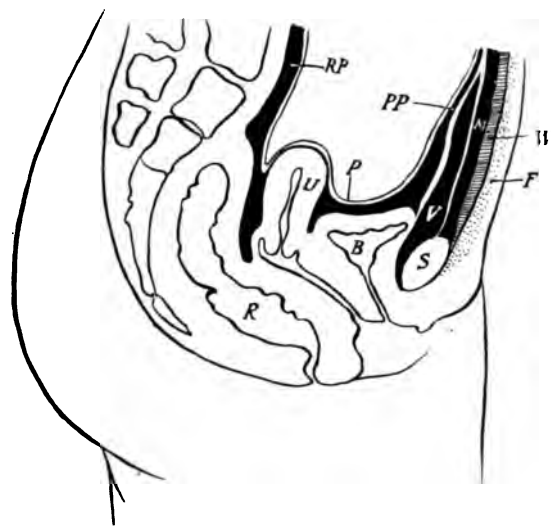

FIG. 177.—LOCATION OF ABSCESSES IN ABDOMINAL WALL, ETC.

R, Rectum; *U*, uterus; *B*, bladder; *S*, symphysis pubis; *F*, skin and subcutaneous tissues; *W*, muscles of abdominal wall; *M*, retromuscular abscess; *V*, prevesical abscess; *PP*, properitoneal abscess; *P*, peritoneum; *RP*, retroperitoneal suppuration extending upward from pelvis.

(*d*) It may be due to disease of the ribs or spine or to a spontaneously perforated empyema (empyema necessitatis).

(*e*) Secondary to perforations of the gall-bladder, intestine, appendix, stomach, and cecum. This group includes actinomycosis following primary intestinal disease.

(*f*) Secondary to infections of the uterus (especially puerperal) and of the adnexa. Puerperal infection may cause a pelvic abscess which spreads to the connective tissue of the iliac fossa and retroperitoneal space (see Fig. 177).

(*g*) The pus may collect in the extraperitoneal subphrenic tissue secondary to appendicitis or hepatic abscess. This is comparatively rare.

The diagnosis in all of these is dependent upon the history and the presence of general and local symptoms of suppuration.

Prevesical abscesses (see Fig. 177) give rise to an area of dullness of

oval form like that of the distended bladder. There is local pain, tenderness, and fever. When the bladder is emptied the tumor still remains. The pus may rupture into the bladder or into the intestine. The tumor can be felt through the rectum or vagina. Inquiry into the history will usually result in finding a primary focus in the bladder, the generative organs, the bones of the pelvis, or the intestine.

In all of the other forms of suppuration within or behind the abdominal muscles the diagnosis may be made from the appearance of a more or less circumscribed area of induration, accompanied by fever, pain, tenderness, and rigidity of the corresponding portion of the abdominal wall. Careful search will usually elicit the primary source of infection.

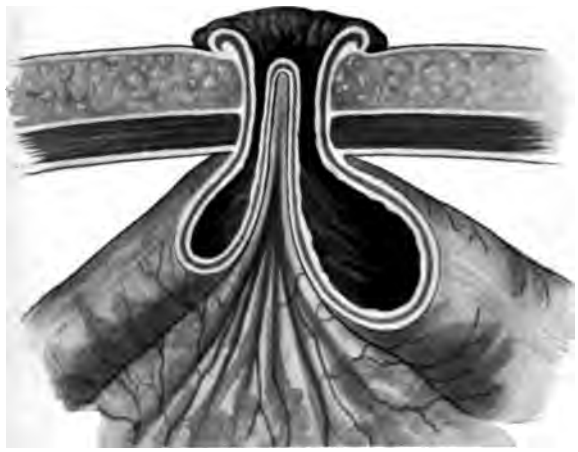

FIG. 178.—FECAL FISTULA OF THE ORDINARY TYPE (R. C. Coffey). Note the openings of the afferent and efferent loops of intestine. The common opening projects above the level of the skin

If there is pus, or even in the case of a tumor in the abdominal wall, both are more prominent when the patient lies down. In the majority of the forms of suppuration in or behind the abdominal wall the diagnosis can be made from the history of a primary infection, the presence of a circumscribed or diffuse infiltration, pain, tenderness, and fever.

ABDOMINAL FISTULÆ.

If one limits the term fistula to a canal lined by granulation tissue which communicates with a preformed cavity, one must look for the cause of abdominal fistulæ in one of the hollow viscera, *e. g.*, small and large intestine, stomach, gall-bladder, urinary bladder, uterus, tubes, etc. The various forms of fistula are best understood by a reference to Figs. 178 to 181. The escape of the normal secretion of the viscus, as in the case of the gall-bladder, or of food in its various stages of digestion, as in the case of the stomach, small and large intestine, or of urine from a vesical fistula, establishes the source of the fistula. The relation of Meckels' diverticulum to fistulæ is referred to on page 255.

TUMORS OF THE ABDOMINAL WALL.

These may occur either in the skin itself or in the deeper layers. Those of the skin are usually *soft pedunculated fibromata* which vary greatly in size and number. Their soft consistency, slow growth, and pedunculation render their recognition easy (Fig. 441). *Pigmented nevi* also occur with considerable variation in size and number. They are of a brownish color, slightly raised above the surrounding skin, and often have long hairs growing from their surface.

Both soft fibromata and pigmented nevi tend to become sarcomatous at times. Such a change can be recognized from the rapid growth of the tumor as well as the tendency to ulceration of the surface. The deeper forms of neoplasms are lipomata and desmoids. *Lipomata* occur as subcutaneous, intermuscular, and subserous growths. The two first named may be recognized by their soft, almost semifluctuating consistency, and especially by their lobulated surface, most marked, as in all lipomata, when the overlying skin is slightly stretched. The subcutaneous lipomata occur most frequently in the median line. They are also lobulated, and cause pain, which is often referred to the stomach.

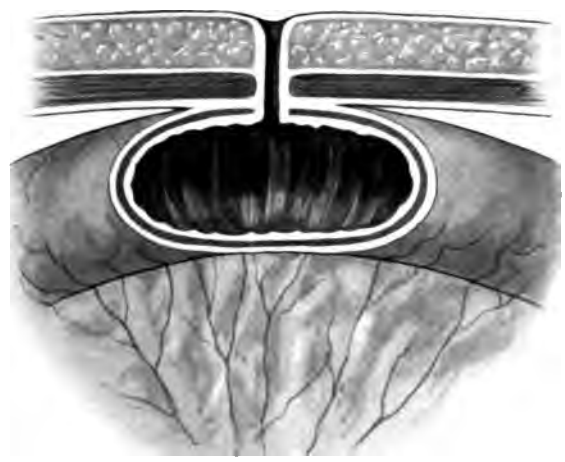

FIG. 179.—FECAL FISTULA WITH SHORT CANAL (R. C. Coffey).

They may be differentiated from herniæ of the linea alba or umbilical hernia by palpation (Fig. 182). In the case of a hernia there is a distinct thrill on coughing and the contents can be reduced into the abdominal cavity unless they are adherent to the sac. In such cases, and when linea alba herniæ become strangulated, a differential diagnosis from lipomata is almost impossible before operation. The occurrence of subserous lipomata in inguinal and femoral herniæ is a frequent observation at operations for the radical cure of these conditions, but they are seldom recognized before operation.

Desmoids are peculiar forms of fibroid tumors, occurring chiefly in women between fifteen and fifty who have borne children. They rarely occur in men. The majority are in the front part of the abdomen below the umbilicus. They are oval in form and vary in size from a hen's egg to that of an adult's head. As a rule, they are hard, but may soften so that cysts are formed which may be hemorrhagic.

They may follow trauma, laparotomy or herniotomy operations, or the prolonged pressure of a belt. They may be painful, especially at the time of the menstrual period. The diagnosis depends on their firm character (the softer cystic degeneration being exceptional) upon the smooth surface, and the fact that they grow in the direction of the corresponding aponeurosis or scar.

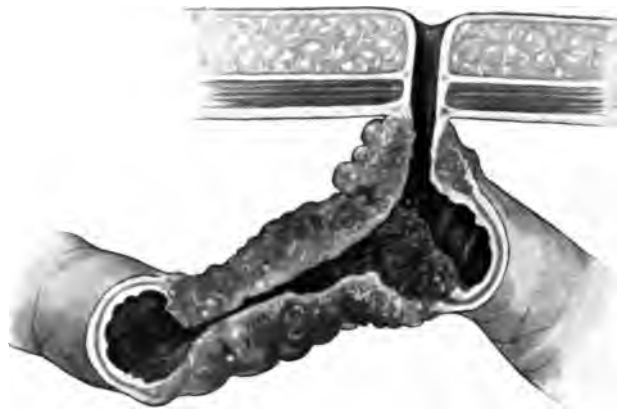

FIG. 180.—FECAL FISTULA DUE TO ULCERATION OF MALIGNANT DISEASE OF INTESTINE AFTER ADHESION OF COIL TO ABDOMINAL WALL (R. C. Coffey).

They may become less prominent when the patient sits up and can be less easily felt than when they lie down. They do not change their position when the patient is turned toward either side, as intraabdominal tumors do.

Differential Diagnosis of Desmoids.—They must be differentiated from an abscess or hematoma of the abdominal wall and from intra-abdominal tumors. A hematoma is gradually absorbed, and an abscess is more sensitive and is accompanied by fever and leukocytosis. In addition, the edges of an abscess are less sharp and there is usually a primary cause (see page 250) to be found.

From intraabdominal tumors and encapsulated exudates there is great difficulty at times in making a differential diagnosis, especially if they have become adherent to the anterior abdominal wall.

If such an adherent intraabdominal tumor be due to carcinoma or sarcoma, there is accompanying cachexia and the history of a rapid growth as compared to the slow growth of desmoids. Other forms of intraabdominal tumors show the characteristics described on page 254.

CONGENITAL CONDITIONS.

These occur most often in connection with Meckel's diverticulum and the urachus. In the former, a number of conditions are found, as follows (Fig. 183):

(*a*) The diverticulum may be patent at the umbilicus with pro-

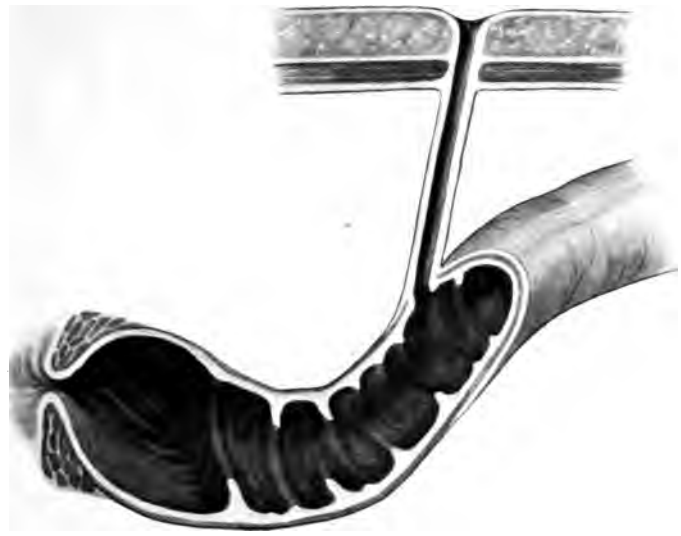

FIG. 181.—ABDOMINAL SINUS DUE TO A FISTULOUS COMMUNICATION WITH THE INTESTINE (R. C. Coffey).

trusion of the posterior wall of the gut. This may be diagnosed from the presence of a soft reddish tumor covered externally with mucous membrane.

(*b*) There may be simply a fistulous opening, with reddish edges, from which a few drops of mucus having a fecal odor are discharged and through which a fine probe can be passed into the intestine.

(*c*) A hernia of the gut may occur as a complication of the posterior wall protrusion.

(*d*) The diverticulum may be large and patulous at the umbilicus. Such a form can be readily recognized.

(*e*) The diverticulum may rarely be converted into a cyst.

Malformations in connection with the urachus are much simpler. Here a fistula is most often present from which both pus and urine are discharged. Cysts of the urachus occur in the median line between the umbilicus and symphysis, and can be suspected to be of this origin chiefly from the characteristic median location. The connection of a fistula with the bladder may be demonstrated by injecting milk or methylene-blue into it and then catheterizing the patient.

FIG. 182.—METHOD OF DETERMINING THE PRESENCE OF AN UMBILICAL HERNIA.

Two fingers, preferably the index and middle finger, of the examiner's hand are placed over the umbilical region, and the patient is asked to cough, when the impulse can be distinctly felt if the hernia is present.

ABSCESSES DISCHARGING THROUGH THE UMBILICUS.

Pus escaping from the navel may have its origin in a number of different sources. It may be the result of a prevesical or retromuscular suppuration dependent on the various primary sources of such infection (see page 250). In addition to the causes in the abdominal wall itself, one must think of intraabdominal causes. In children it is a frequent point of spontaneous discharge of a tubercular peritonitis. Suppurating echinococcus cysts and abscesses resulting from perforations of the various hollow viscera, all are apt to discharge through the navel.

TUMORS OF THE UMBILICUS.

These may be primary or secondary. At times the discovery of the secondary growth at the navel may be the first sign of an intraabdominal malignant disease.

The primary tumors belong to both the benign and malignant forms. Of the former, the most frequent are dermoids and sebaceous cysts, which can be recognized by their soft doughy consistency and slow growth.

The primary malignant tumors are almost always carcinomata and grow rapidly, appearing either in the form of a cauliflower-like growth with firm edges or as an ulcerating surface with typical indurated edges and base. There is also accompanying indurative enlargement of the inguinal lymph-nodes.

The secondary tumors simply cause a hard tumor protruding at the umbilicus, and appear rather as the result of a direct continuation of a widespread peritoneal dissemination than as a metastasis. They are due in two-thirds of the cases to malignant disease of the alimentary tract or liver, in the remaining one-third to that of the ovaries and uterus.

INJURIES OF THE ABDOMINAL WALLS AND VISCERA.

Our views in regard to the indications for operation have changed so rapidly during the past fifteen years that it has greatly influenced the question of diagnosis. Up to that time an exploratory laparotomy was only indicated in every suspected injury of the abdominal viscera if symptoms of peritonitis had appeared.

At present more progressive surgeons believe that visceral injuries resulting from stab or gunshot wounds, as well as severe crushing injuries, should be diagnosed early enough to be of aid in saving the patient's life, *i. e.*, within the first six to twelve hours.

When such a patient is examined for the purpose of making a diagnosis, a certain more or less fixed routine method should be followed in order to ascertain, as soon after the accident as possible, whether a viscus has been injured. Often such a decision can only be reached if the patient is examined a second or third time in a similar manner one to two hours later.

The routine method is as follows:

1. Ascertain as accurately as possible the exact manner in which the accident occurred.

2. General condition of the patient.

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The routine method is as follows:

1. Ascertain as accurately as possible the exact manner in which the accident occurred.

2. General condition of the patient.

3. Results of local and general examination.

4. Symptoms of injury of particular viscera.

Before discussing these in detail, it may be stated that injuries in which there is no external wound are just as likely to produce serious visceral lesions, as those in which there is a cutaneous wound. In civil life the former class is far more frequent than the latter, and with the possible exception of those cases in which there is actual prolapse of viscera following the action of some penetrating force, the diagnostic

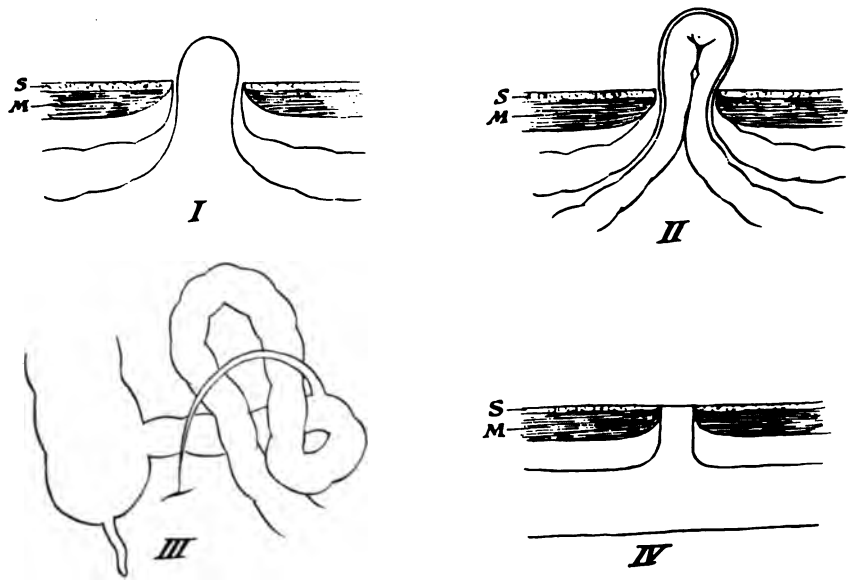

FIG. 183.—MOST FREQUENT CONDITIONS OCCURRING IN CONNECTION WITH MECKEL'S DIVERTICULUM (Miles F. Porter).

S, Skin; *M*, abdominal wall. I. Posterior wall of Meckel's diverticulum prolapsed through umbilicus. II. Hernia of Meckel's diverticulum. A coil of intestine is seen pushing the posterior wall of the diverticulum outward. III. Intestinal obstruction due to Meckel's diverticulum. The latter is seen attached to some point in the abdominal cavity causing strangulation of a coil of intestine which had slipped beneath its point of origin and attachment. IV. Fistula at umbilicus due to patent Meckel's diverticulum.

points of both penetrating and non-penetrating wounds are the same, so that they will be discussed together.

1. **History and Mode of Accident.**—In stab wounds it will be of confirmatory value to know the length of blade, the relative positions of victim and assailant, and the direction in which the instrument, such as dagger, sword, bayonet or knife, was thrust in if possible.

In gunshot or shell wounds, the size of the bullet or missile is of value. It has been found that small bullets traveling with great velocity do far less damage than larger and more explosive ones. Too much weight should, however, not be placed upon this difference, since

wounds of the hollow viscera may cause as serious results after small as after large perforations. If the stomach or intestines were empty before the accident, the results of a perforation are far less serious than if a meal had just been eaten.

In the case of subcutaneous injury we can divide them into those in which there is perhaps only slight abrasion or contusion externally, and the graver cases in which there is a hernial protrusion. The modes of injury are, as in the skull, chiefly of three varieties:

(*a*) A circumscribed force or one which has come into contact with the abdomen over a limited area only. As examples of this class may be mentioned kicks, or a fall upon some object, or a blow from a tool like a hammer, etc., thrown at the lower portion of the patient's thorax or over the abdomen proper.

(*b*) A diffuse force or one in which one segment or the entire abdomen has been compressed between two opposing forces. Such action follows accidents like being caught between buffers or in the wreck of a building.

(*c*) An indirect mode of injury such as follows a fall upon the feet or the falling of a weight upon the back.

2. **General Condition of the Patient.**—There are four classes of cases:

(*a*) Those with marked primary shock symptoms from which the patient never recovers, death ensuing in a short time after the injury.

(*b*) Those with marked primary shock symptoms passing imperceptibly into those of internal hemorrhage, either terminating fatally within a few minutes to hours, or the signs of internal hemorrhage continue so that a diagnosis of the injury of a viscus with escape of blood can be made.

(*c*) Cases with practically no general symptoms and in which the suspicion of an abdominal injury only arises from the history of the mode of injury or the gradual appearance of local signs indicating hemorrhage or beginning peritonitis. There are also cases in which the symptoms appear on the second day, or even as late as the tenth day, from dislodgment of a clot.

(*d*) Cases in which there is apparently considerable primary shock which clears up without any local injury being discovered. This last class is the most puzzling from a diagnostic point of view.

Under shock symptoms may be included pallor of the skin and visible mucous membranes; rapid, weak pulse and respiration; cold, clammy sweat; stupor or unconsciousness; lowering of blood-pressure; dilated pupils; and vomiting immediately after the accident.

In making an examination of the general condition of the patient one should note whether the above symptoms of shock are present or absent. In case they are present and persist for more than a few hours, one must look for local signs of injury. If the patient does not react, one must look for some cause in the abdomen.

Extreme pallor, a weak, rapid pulse with but little tension, thirst, restlessness, shallow respirations, and a decrease in blood-pressure, as determined by the Riva Rocci instrument or its modifications, indicate internal hemorrhage. If such is the case, it may be impossible to distinguish it from shock except by the absence of unconsciousness, of cold, clammy skin and dilated pupils in hemorrhage (see page 790). There are cases in which the symptoms of both shock and internal hemorrhage appear immediately after the accident, so that it is impossible to distinguish between them until some hours have passed and the hemorrhage symptoms predominate. If the condition is due to hemorrhage the patient becomes paler, more apathetic and somnolent, the pulse gets smaller and more rapid and the respiration shallower, even when there is no peritonitis present. The writer has, on the other hand, seen a number of cases of severe intraperitoneal hemorrhage in which the pallor was not a noticeable feature, the primary anemia having been partially recovered from. These exceptions are particularly mentioned to emphasize the fact, first, that in some cases it is almost impossible to make a diagnosis before operation; and, secondly, that too much reliance should not be placed on any one symptom.

3. **Local Signs of Injury.**—(*a*) Examination of the skin and abdominal wall. In the case of penetrating wounds the situation of the wound of entrance and of exit, if the latter exists, is of some value in determining which structure has been injured. If the wound of entrance is in such a position, *e. g.*, in the thorax, as to lead to the suspicion that the missile or knife has passed through the diaphragm from the thoracic into the abdominal cavities, one should always search for signs of injury to the abdominal viscera. (See Figs. 146, 147.) Reference has already been made on page 214 to these cases of thoraco-abdominal injury or wounds of the diaphragm.

In former times great stress was laid upon the fact that many gunshot or stab wounds did not penetrate into the abdominal cavity. At present the opinion of the majority of surgeons is that no time should be wasted in speculating whether or not a missile or knife has penetrated, but exploratory operation should be performed. Under no conditions should a wound be probed or enlarged, however, until the proper aseptic technic and surroundings have been secured in order to make a diagnosis by direct inspection.

In injuries of the abdominal wall or viscera with but slight or no external signs, one should note the presence of an accompanying fracture of the lower ribs or of cutaneous hematomata. In the same manner the presence of a palpable gap in the abdominal muscles, with or without the appearance of a swelling having all the characteristics of a hernia (see page 463), is of value.

The most important local signs, aside from those to be seen or felt externally in the early hours (six to twelve hours) after either a penetrating or non-penetrating injury, are:

(*a*) ***Muscular rigidity.***

(*b*) ***Localized or diffuse pain and tenderness on pressure.***

(*c*) ***Dullness in the flanks or above the pubes.***

The muscular rigidity is due to a reflex contraction of the abdominal muscles, called the "defense muscelaire" by French surgeons. It is one of the most characteristic symptoms and is quite marked at an early stage over the injured viscus. The same is true for the pain and tenderness on light pressure which usually accompany the rigidity. These symptoms are indicative either (*a*) of peritoneal irritation due to the presence of blood, or (*b*) of peritonitis, due to the escape of bowel or bladder contents. This rigidity and tenderness extend over the entire abdomen. The steady increase in the pulse-rate and in the degree of tympanites, and the onset of vomiting, etc., soon show the presence of a complicating peritonitis. If pain is due to injury of the abdominal wall alone, muscular rigidity is never as marked.

In the early hours after an injury, especially in those cases in which there are practically no signs of shock or internal hemorrhage, one can detect dullness in the flanks or above the pubes. Such dullness, if it changes to tympany when the patient is turned upon the opposite side means free blood or urine in the peritoneal cavity. If the dullness is only above the pubes and does not vary with change of position it is due to an extraperitoneal rupture of the bladder (see page 264). Unfortunately free fluid can seldom be demonstrated at an early stage owing to the muscular rigidity. At a later stage its presence is obscured by the tympanites. The author has found dullness due to free blood in the peritoneal cavity most often above the pubes.

4. **Symptoms of Injury of Particular Viscera.**—A convenient division of the symptoms of injury of the individual viscera for the purpose of diagnosis is:

(*a*) Those cases in which symptoms of injury of the alimentary canal predominate.

(*b*) Those in which symptoms of injury of the urinary organs predominate.

(*c*) Those in which signs of internal hemorrhage predominate.

Symptoms of Injury of the Alimentary Canal.—*Vomiting.*—Nausea or vomiting continuing for some hours after the receipt of an injury are very characteristic signs of the presence of an injury to the stomach or small intestine. If the vomitus contains blood, it indicates an injury to the stomach. If the vomiting is bilious in character, a wound of the small intestine should be suspected.

Obliteration of the Liver Dullness.—This sign, if present in the form of tympany replacing a normal hepatic dullness, is of great value. Unfortunately, however, it is rarely present, so that but little weight can be placed upon its absence.

Presence of Evidence of Free Fluid in the Peritoneal Cavity.—As was stated above, the presence of free fluid in sufficient quantities to permit of its detection by percussion is so rare in the early hours of a stomach or intestinal injury as to be of little value. If, however, a changing line of dullness in the flanks and above the pubes can be found, it is indicative of such visceral perforation. One must, however, exclude the possibility of intestinal coils full of fluid feces or the possibility of free hemorrhage giving rise to the same signs.

The most typical symptoms at an early stage of gastric or intestinal perforation are the gradual rise in the pulse-rate and the presence of an increasing leukocytosis. If an increase in the pulse-rate is not due to primary shock or hemorrhage, such an increase is strongly indicative of a beginning peritonitis.

Tympanites.—If in a patient who has sustained an injury of the abdomen in any of the modes above described there is a gradual increase in the distention of the abdomen and other symptoms, such as inability to pass flatus, there can no longer be any question as to the existence of a perforation. As was stated above, in the majority of cases a diagnosis made when tympanites is marked is of comparatively little value from an operative standpoint, since septic paresis of the intestines is already well advanced.

The passage of blood in larger or smaller quantities with the bowel movement is also a positive sign of intestinal injury. If black and tarry in character, it indicates hemorrhage high up toward the stomach or the duodenum. If fresher in color it indicates hemorrhage lower down.

The pain, tenderness, and rigidity of the abdominal wall are often quite localized in gastric or intestinal injury. This is especially true of those cases of appendicitis which apparently seem to follow directly upon the reception of an injury.

Symptoms of Injury of the Urinary Organs.—This includes injuries of the kidneys and ureter.

Injury of the Kidney.—If the wound in the kidney communicates freely with the general peritoneal cavity, it produces the same symptoms of internal hemorrhage as those in which there is perforation of solid viscera like the liver and spleen, and will be referred to below. Injury of the kidney in which there is no such communication causes pain, and not infrequently, swelling over the lumbar region. The pain is apt to radiate along the ureter into the testis or thigh upon the side of the injury. There is also tenderness over the kidney and considerable rigidity of the lumbar muscles. The most characteristic symptom, however, of injury to the kidney is the presence of hematuria. In

FIG. 184.—EXTENSIVE DESTRUCTION OF KIDNEY.
The organ is completely lacerated. It occurred in a case of subcutaneous injury of the abdominal wall without external sign. (See text.)

bleeding from the kidney the blood is intimately mixed with the urine and accompanied by worm-like clots which are casts of the ureter, whose passage down along the ureter cause the colicky pains just spoken of. The hematuria is, as a rule, most marked just after the reception of an injury, gradually diminishing in quantity. Even the symptom of hematuria may at times be absent, and yet extensive lacerations of the kidney have occurred, as in the case recently observed by the author in which there was pulpification of the kidney without any blood in the urine, as a result of a crushing injury. The ureter was blocked by a large clot so that no hematuria occurred. Fortunately such cases are very rare.

In order to state positively that hematuria is from the kidney the bladder should be washed out and some of the irrigating solution left

over the epigastrium, and often distention of the upper abdomen. Fractures of the lower ribs accompany the subcutaneous injuries of the liver and spleen in many cases, and one must always look for such injuries in cases of fractures of the sixth to tenth ribs inclusive.

ACUTE ABDOMINAL AFFECTIONS.[1]

When called to the bedside of a patient suffering from an acute abdominal condition, every effort should be made to make a diagnosis at an early period. This is often impossible until the patient has been examined several times during the course of a few hours or even days, in order to observe the development of the various symptoms upon which a diagnosis can be made.

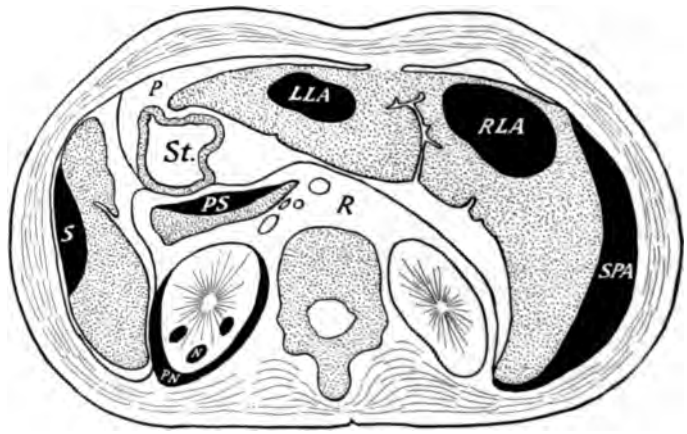

FIG. 186.—LOCATIONS OF VARIOUS FOCI OF SUPPURATION IN ABDOMINAL CAVITY.

SPA, Subphrenic abscess pushing liver away from abdominal wall; *RLA*, abscess of right lobe of liver; *LLA*, abscess of left lobe of liver; *PS*, peri-pancreatic suppuration; *N*, location of abscesses within kidney (pyelonephritis); *PN*, location of perinephritic suppuration; *P*, peritoneal cavity; *St*, lumen of stomach; *S*, abscess of spleen; *R*, retroperitoneal tissue.

This diagnosis should not only include the viscus involved, but the character of the pathologic process.

In the examination of such a case it is well to have a more or less systematic method of examination, in order that no organ may be overlooked.

There is no one group of symptoms common to all acute abdominal conditions. On the other hand, symptoms so group themselves that it will be found of aid to divide the cases into four classes. The lines between these are not sharply drawn because occasionally cases apparently belonging to one group will be found to belong more properly

[1] The above grouping, although an arbitrary one, is very useful at the bedside.

to one of the others. For practical purposes, however, such a classification will be found useful clinically, and is as follows:

1. Those in which inflammatory symptoms appear early and predominate.

2. Those in which pain of varying intensity is the prominent symptom. It may be followed by signs of localized or diffuse peritonitis or by the symptoms of intestinal obstruction.

3. Those cases in which the symptoms of intestinal obstruction are the most prominent from the onset.

4. Those in which either shock or hemorrhage or both are marked, and are followed by signs of peritonism (signs of bowel paralysis of milder degree than in obstruction).

The various acute conditions which can thus be classified are:

GROUP I.	GROUP II.	GROUP III.	GROUP IV.
EARLY SYMPTOMS OF SUPPURATION.	PAIN A PROMINENT EARLY SYMPTOM FOLLOWED OR NOT BY SIGNS OF PERITONITIS OR INTESTINAL OBSTRUCTION.	EARLY SIGNS OF INTESTINAL OBSTRUCTION.	EARLY SIGNS OF INTERNAL HEMORRHAGE.
1. Acute cholecystitis.	1. Appendicitis.	All forms of intestinal obstruction.	1. Extrauterine hemorrhage.
2. Hepatic infections. (*a*) Single and tropical abscess. (*b*) Suppurative pylephlebitis. (*c*) Catarrhal and suppurative cholangitis.	2. Gallstones or biliary colic.	(*a*) Strangulation by bands, by adhesions through apertures, or by Meckel's diverticulum. (*b*) Volvulus. (*c*) Intussusception. (*d*) By tumors or foreign bodies. (*e*) Adynamic ileus.	2. Rupture of aneurysms.
3. Peritonitis. (*a*) Acute tuberculous. (*b*) Pneumococcus. (*c*) Gonorrheal. (*d*) So-called idiopathic. (*e*) Secondary to visceral disease, operations and wounds.	3. Perforation of hollow viscera. (*a*) Gastric ulcer. (*b*) Duodenal ulcer. (*c*) Typhoid ulcer.		
4. Renal infections. (*a*) Pyonephrosis. (*b*) Pyelonephritis. (*c*) Perinephritis.	4. Acute pancreatitis.		
5. Subphrenic abscess.	5. Renal colic.		
6. Suppurating echinococcus cysts of the liver.	6. Kinking of ureter in floating kidney (Dietl's crises).		
7. Diverticulitis.	7. Embolism or thrombosis of the mesenteric vessels.		
8. Multiple abscesses of omentum.	8. Torsion of pedicles of ovarian or uterine tumors.		
9. Retroperitoneal glandular suppuration.	9. Torsion of spermatic cord.		
	10. Visceral crises in tabes or in erythema group.		
	11. Angina sclerotica abdominis (Ortner's disease).		
	12. Referred pain from thoracic or spinal affections.		
	13. Inflammation of intraabdominal portion of vas deferens.		

Group I.—Early Symptoms of Suppuration.

1. ACUTE CHOLECYSTITIS.

In acute cholecystitis, occurring without gallstones, there is severe pain referred to the gallbladder region, tenderness and muscular rigidity over the same area, fever, vomiting, leukocytosis, and an increased pulse-rate. In addition, an area of dullness can be outlined by percussion and a tumor felt at times by palpation just below the right costal arch.

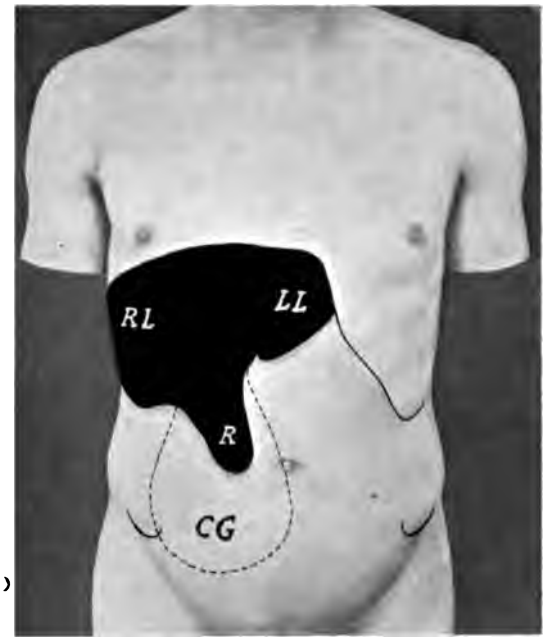

Fig. 187.—Riedel's Lobe of Liver and Area of Dullness or Tumor Due to Cystic Enlargement of the Gallbladder.

RL, Right lobe of liver; *LL*, left lobe of liver; *R*, Riedel's lobe; *CG*, cystically dilated gallbladder.

If the liver is located at a lower level in the abdominal cavity, as the result of a hepatoptosis, or if there is a long Riedel's lobe which has carried the gallbladder with it (Fig. 187), all of the above signs are found at the level of the umbilicus or even below it. If pus has formed in the gallbladder (empyema) the fever is higher and continuous in type, and the leukocytosis quite marked. In cholecystitis complicating typhoid the symptoms are often overshadowed by those of the typhoid itself. Such cases show a distinct Widal reaction.

Differential Diagnosis.—1. *Appendicitis.*—In appendicitis the tenderness and rigidity are lower down, fever and leukocytosis are not so marked in the early hours, and there is more apt to be severe colicky pain.

If, however, the gallbladder is located lower than normal (see Fig. 187) the differentiation between a cholecystitis and an appendicitis may be very difficult, and at times impossible.

2. *Gallstone Colic.*—In gallstone colic, the same local signs appear

as in cholecystitis, but there is less fever, less leukocytosis, and less constitutional disturbance, and the pains are far more severe and radiate to the right shoulder, less often than to the left.

3. *Gastric Ulcer.*—The differential diagnosis is often difficult between attacks of cholecystitis and the attacks of pyloric spasm or of pain following the ingestion of food in gastric ulcer. In the latter the pain is oftener nearer the median line than in the case of an inflamed gall-bladder. The pains in gastric ulcer occur daily for weeks, and begin within three to four hours after the ingestion of food. The pain is usually referred to the epigastrium, whence it radiates to the left. Vomiting is a frequent symptom of ulcer, and as a rule, gives immediate relief. Taken altogether, the inflammatory symptoms are less marked in gastric ulcer than in cholecystitis. Both conditions may, however, coexist.

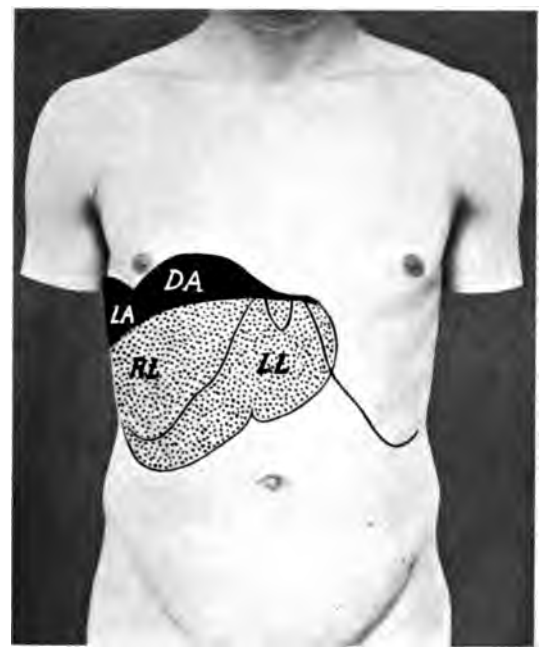

FIG. 188.—AREAS OF DULLNESS FREQUENTLY OBSERVED IN RIGHT-SIDED SUBPHRENIC ABSCESSES, AND IN ABSCESSES OF THE RIGHT LOBE OF THE LIVER.

RL, Right lobe of liver; *LL*, left lobe of liver; *LA*, abscess of lateral subphrenic space; *DA*, abscess of dome of diaphragm.

Phlegmonous Cholecystitis.—This grave form of cholecystitis can be recognized by the greater severity of the initial symptoms. The pain in the right hypochondrium is more severe and sudden in its onset than in gallstone colic, and there is far more general disturbance. These latter septic symptoms are rapid, feeble pulse, cold sweats, subnormal temperature, collapse, faintness, great prostration, and the early appearance of the signs of a general peritonitis.

2. HEPATIC INFECTIONS.

SINGLE AND TROPICAL ABSCESS.

The occurrence of irregular fever accompanied by chills, sweats, and pain on palpation over the liver and enlargement of that organ especially in an upward direction (Fig. 188), in a patient who has previously suffered from dysentery or who has lived in a tropical climate, should lead one to suspect an abscess of the liver. A bulging below the right costal arch will confirm such a diagnosis.

The pain in abscesses of the right lobe is often referred to the right shoulder, and in those of the left side, to the corresponding scapular region. Icterus is absent in the majority of cases.

FIG. 189.—MULTIPLE ABSCESSES OF LIVER.
Due to a septic pylephlebitis secondary to appendicitis.

The fever may be quite regularly intermittent, like a malarial, but is usually quite irregular. The only other hepatic conditions in which such an irregular fever of the intermittent type occurs is in some cases of syphilis of the liver, and also in cholangitis complicating common-duct obstruction by calculi. In the latter icterus is always present.

The liver is enlarged in all directions, but this is most marked in an upward direction, so that the liver dullness is increased especially in the mammary and axillary lines. The tenderness may at times be quite localized over the abscess. Exploratory puncture is of great value in confirming the presence of pus. A negative result does not exclude an abscess, as the needle may become occluded or pass through the abscess. One should always search for the etiologic factor which produced the abscess, *e. g.*, amœbæ in the stool in the case of the tropical abscess, ap-

pendicitis or other inflammatory affections in the area drained by the portal veins.

Differential Diagnosis.—1. *Right-Sided Empyema.*—The liver is not enlarged in a downward direction. There are marked signs of compression of the lung, if the empyema is a diffuse one and the upper border of the area of dullness is either concave upward or horizontal, while in hepatic abscess it is convex (Fig. 188) and the septic symptoms are more marked in abscess of the liver. If an empyema and hepatic abscess coexist a differentiation is impossible. The same is true for an encapsulated supradiaphragmatic empyema.

2. *Malaria.*—The absence of leukocytosis, the presence of an enlarged spleen, the inefficacy of quinin, and the finding of plasmodia serve to distinguish this disease. It must not be forgotten that in some cases of malaria, the organisms are not found until after quinin has been administered.

3. *Suppurative Pylephlebitis or Cholangitis* (see below).

4. *Subphrenic Abscess.*—(See page 285.)

SUPPURATIVE PYLEPHLEBITIS, OR MULTIPLE ABSCESSES OF THE LIVER.

This most frequently follows appendicitis, toward the end of the attack. It may, however, follow suppuration in any viscus whose veins empty into the portal circulation. The infective process extends from the inflamed viscus into the portal veins, causing a thrombophlebitis which in turn extends into the terminal branches of the portal vein within the liver, resulting in multiple abscess formation. Cases have been recently described in which the thrombophlebitis was primary in the portal circulation, and not secondary to infective conditions in the appendix, hemorrhoidal, gastric, or duodenal veins. Quite rarely an acute pancreatitis is the source. A search for a primary cause should always be made. It results in the formation of multiple abscesses in both lobes of the liver (Fig. 189). It may often follow what were interpreted clinically to have been mild cases of appendicitis.

If a septic or pyemic condition follows appendicitis either a pylephlebitis or a subphrenic abscess must be thought of. In pylephlebitis there are chills, irregular fever, sweats, jaundice, and a uniformly enlarged and very tender liver. There is no tendency to the formation of a solitary tumor, as in the case of a single abscess. The patients appear to be far more septic than in a single abscess and soon succumb to the pyemia.

Differential Diagnosis.—1. *From Tropical Abscess.*—The clinical

occur in young girls without the history of a previous vulvovaginitis. Riedel[1] has called attention to a number of cases of acute fulminating peritonitis in little girls ranging in age from four to twelve years. All of his eight cases died after a most rapid course, and the autopsies showed an absence of appendiceal disease as the cause of the peritonitis. All of the children had an acute salpingitis, which was without doubt the source of the infection. Such a salpingitis may be as often due to the ordinary pyogenic cocci as to the gonococcus. The clinical picture may be that of a diffuse peritonitis or of the more encapsulated variety. The author has seen one of each of these in little girls of ten and twelve respectively.

Pneumococcus Peritonitis.—This occurs almost exclusively in young children of both sexes. It may accompany or follow thoracic conditions, such as pericarditis or empyema, or occur independently.

The diagnosis may be made from the age and the sudden onset of peritonitic symptoms, such as fever, abdominal distention, vomiting, and tenderness, followed in a few days by diarrhea and later by the formation of a tense cystic mass in the hypogastrium accompanied by fever and signs of exhaustion.

So-called Idiopathic Peritonitis.—From time to time cases of acute peritonitis are reported in which after careful search, either during operation or, in some instances, after death, it was impossible to find the atrium of infection. Such cases have been called peritonitis without ascertainable cause and also idiopathic peritonitis. The former would seem to be the better term to employ. In a considerable proportion of these cases the microörganisms have undoubtedly migrated the macroscopically intact but inflamed wall of the appendix or intestine. Noetzel,[2] Hirschel,[3] Sprengel,[4] and the author[5] have reported a number of such cases of peritonitis without visible perforation of the appendix. The clinical signs are the same as in the next group.

Secondary Peritonitis.—The majority of cases of peritonitis are secondary to some disease of one of the abdominal viscera or one of the structures adjacent to the peritoneal cavity. In some cases it is impossible to demonstrate the atrium of infection. The latter class have been given a special name, "peritonitis without demonstrable lesion," but the number of such cases is rapidly decreasing. Riedel has called attention (see page 273) to the fact that a fair proportion of cases of peritonitis in little girls is the result of an infection which has been carried to the peri-

[1] "Archiv für klinische Chirurgie," volume lxxxi.
[2] "Beit. z. klin. Chir," vol. xlvii. [3] Ibid., vol. lvi.
[4] "Deutsche Chir.," vol. upon appendicitis, p. 227.
[5] "American Jour. of Surg.," Dec., 1908.

toneum through the medium of the vagina, uterus, and tubes. These may present the clinical picture of a most virulent peritonitis, and are not, as might be thought, due to gonococci, but more frequently are caused by the ordinary pyogenic cocci or the colon bacillus. In both children and adults, peritonitis unquestionably results from the migration of bacteria through the intact walls of the hollow viscera. This is especially true of the vermiform appendix, and the author has recently[1] called attention to the fact that a typical general peritonitis may follow an appendicitis without perforation. Noetzel, Sprengel, Lennander and a number of other surgeons have noted similar cases.

In the majority of cases, however, infection in secondary peritonitis travels through some demonstrable perforation in one of the abdominal viscera or is transmitted from an adjacent suppurating focus, usually by way of the lymphatics. An example of the latter is the peritonitis following septic abortion or an infection of the uterus during or after labor. It is impossible in a work devoted to diagnosis to more than enumerate some of the possible sources of secondary peritonitis. These may be classified as follows:

1. Perforations which are due to injury. These forms of peritonitis may follow a wound of any hollow viscus, *e. g.*, stomach, intestine, or urinary bladder, or peritonitis may be the result of infection carried into the peritoneal cavity by the missile itself.

2. Perforations which are due to disease. In the stomach and duodenum the perforation of an acute ulcer is very rare, while that of a chronic indurated ulcer is not at all infrequent. Perforations of tuberculous, syphilitic, or carcinomatous ulcers of the entire alimentary tract occur very seldom. In the small and large intestine one must recall the frequency of perforations of typhoid; less often of dysenteric ulcers. In the case of the appendix, perforation is quite common, often distal to a stricture or over the site of an enterolith. Perforation of a diverticulum of the sigmoid flexure with secondary peritonitis is described on page 289. Peritonitis may occasionally be the result of a gall-bladder perforation.

3. Ileus. Secondary peritonitis following almost all of the various forms of acute obstruction is the result of circulatory changes in the bowel wall which permit of the migration of bacteria through the pathologic tissue.

4. Gangrene. This is a frequent cause of secondary peritonitis, and, as in cases of ileus, the migration of bacteria is possible through the diseased bowel wall.

[1] "American Journal of Surgery," Dec., 1908.

5. Infective processes in the liver, spleen, pancreas, appendix and uterus are often followed by peritonitis, either through rupture of the infected focus into the peritoneal cavity or migration of organisms through diseased tissue.

6. The female genitalia. These are of the greatest importance in the production of a peritonitis, either from gonorrheal infection of the uterus and tubes or infection following abortion or during labor. Infection of the peritoneum from the male genitalia is quite rare.

The most important points in the pathology of peritonitis are: (1) The extent of the process; *i. e.*, whether localized, spreading, or general. (2) The character of the exudate. (3) The change in the visceral and parietal peritoneum.

In regard to the first point, viz., the extent of the process, the most generally accepted division is into (*a*) the extent of peritoneum involved is relatively small and corresponds in location to the atrium of infection. (*b*) A spreading peritonitis, also called the progressive fibrino-purulent peritonitis of Mikulicz. The infection does not involve the whole peritoneum at once, but is gradually progressive. In this form the disease usually starts from some one point of infection, where the inflammatory reaction leads to the formation of a protective wall of adhesions, as in the localized form just described. Gradually the infection spreads to the adjacent parts of the peritoneum, so that fresh purulent foci continue to be formed, until eventually the greater part of the peritoneum is involved in this process. Lennander distinguished a variety of this progressive peritonitis in which multiple encysted abscesses form. (*c*) A general peritonitis. There has been considerable discussion as to whether an involvement of the entire peritoneal cavity ever exists. There can be no doubt that in advanced cases such a universal involvement does exist. The majority of cases, however, which are seen by the surgeon during operations for peritonitis following any of the causes just enumerated, are general in the sense that there is no tendency to any walling off of the infection, and that, so far as the eye can see, the peritoneal reaction is general. There are no doubt cases of peritoneal sepsis in which the infection is so virulent that the greater part of the peritoneum is involved within a few hours, with few accompanying macroscopic changes in the peritoneum.

The character of the exudate. This may be serous, sero-purulent, purulent, or hemorrhagic. In some cases, *e. g.*, in peritoneal sepsis, there may be no exudate at all. The changes in the peritoneum vary from deep injection of the blood-vessels to the most advanced denudation of the endothelial covering. At times, in addition to the exudate there

are many flakes of fibrin in the fluid and upon the distended coils of intestine. One of the earliest results of a peritonitis is the distention of the intestines, due to a septic paralysis of the musculature of the viscera.

Diagnosis.—The diagnosis of peritonitis must be made from a careful survey of certain local and general symptoms, to be named in the order of their importance.

Local Symptoms: (*a*) Pain and Tenderness. One of the most characteristic symptoms, especially in perforative peritonitis, is pain. Pain is much more constant in cases where the peritonitis is secondary to a perforation as the result of disease, than in a perforation due to subcutaneous or penetrating injury, or where the peritonitis follows gangrene of a viscus. In some cases the pain may be so severe as to cause collapse. The pain in the perforative form is in reality due to the perforation and not to the inflammation. The pain is at first localized in perforation, but soon becomes more diffuse. As a result of the pain the breathing is shallow and the limbs are drawn up. The tenderness is, like the pain, at first quite circumscribed, but as the infection spreads it becomes more general. Pain and tenderness are always most marked during the first forty-eight hours. After this period the intestinal distention and exudate obscure both of these symptoms.

(*b*) Muscular Rigidity. This is one of the most valuable signs of a peritonitis. *Its extent is an accurate index of the extent of the infection.* In a localized peritonitis it is always limited in extent. The spread of the infection can often be watched from hour to hour by the successive involvement of adjacent areas of the abdominal wall, until the entire abdomen becomes rigid. This muscular rigidity is an involuntary reflex act, and has been properly termed the "*defense musculaire*" by French surgeons. One must never insert the finger-tips deeply into the abdomen in order to ascertain whether muscular rigidity is present. The most useful method is to sit down at the patient's bedside and lay the hand flat upon the surface and then gently palpate the entire abdomen. The muscular, board-like rigidity often persists during deep anesthesia, but may be absent if the patient has been given large doses of morphin.

(*c*) Nausea and Vomiting. Persistent nausea and vomiting should always excite suspicion of a beginning localized or general peritonitis, when they are accompanied by pain, tenderness on pressure, and muscular rigidity. The onset of a perforation is often characterized by severe pain, nausea, and vomiting. The most typical feature of the vomiting in such cases of incipient peritonitis is the recurrence and persistence of the vomiting. The vomitus in the early stages consists of

stomach contents and mucus, later bile is mixed with it, and in advanced cases the vomitus is brownish-black, with a slight fecal odor.

(*d*) Constipation. This is also a valuable symptom, but, like the vomiting, may also occur in ileus of the non-septic type. In the early hours of a peritonitis, the patient may be able to pass flatus or feces spontaneously or with the aid of enemata or the high rectal tube. In cases of localized peritonitis, this condition usually persists throughout the disease, unless, as occurs in some cases of pelvic abscess, especially after appendicitis, the rectum is compressed by the exudate. In general peritonitis, on the other hand, there is no response to the insertion of the rectal tube or enemata. Such an absolute constipation is one of the most characteristic evidences of a general peritonitis.

(*e*) Abdominal Distention (Tympanites). It was formerly thought that one must wait for the appearance of abdominal distention before making a diagnosis of a local or general peritonitis. In the former (localized peritonitis) the abdominal distention is usually stationary and does not increase. In general peritonitis the distention is progressive, becoming more marked as the intestinal septic paralysis involves more and more coils. One should, therefore, never wait for its appearance, since it is a sign of serious damage to the intestinal coils which have lost their peristaltic function. The diagnosis must be made earlier, from the history, pain, tenderness, muscular rigidity, vomiting and constipation. In advanced cases the distention is extreme, causing marked ballooning of the abdomen and displacement of the heart and lungs. The clinical picture of pinched face (the Hippocratic facies), small wiry pulse, enormously distended abdomen, incessant vomiting, dry tongue, subnormal temperature, are so familiar as to require no description here.

(*f*) Exudate. The amount and character of the exudate cannot be diagnosed. In localized processes the appearance of dullness usually means adhesions or exudate.

General Symptoms: (*a*) Pulse. In the early stages the pulse has a peculiar "wiry" character. One of the most characteristic signs of a peritonitis is the progressive increase in the pulse-rate. This is especially true of cases of general peritonitis. In the localized forms, the pulse-rate remains more or less stationary, while in a general peritonitis, it increases in rate from hour to hour. It is exceptional to find a low pulse-rate in peritonitis unless the infection be a very mild one.

(*b*) Temperature. Some writers believe that the presence of fever is one of the most constant signs of a peritonitis. There is no definite type of fever in acute peritonitis, and in general it may be said that the presence of fever is so uncertain a sign as to be of little value in making a diagnosis of peritonitis. The more severe forms of general peritonitis are often

accompanied by only moderate temperatures (100° to 102° F.). There is no relation between the pulse-rate and the temperature. The latter may be only slightly above normal and yet the pulse-rate be enormously increased.

Blood Examination. The degree of leukocytosis is often a valuable guide as to whether localizing processes are taking place. As a rule, a gradually increasing leukocytosis indicates an encapsulation of the exudate. In general peritonitis the degree of leukocytosis depends upon the patient's resistance. In very severe forms there is often no increase, or in some instances a leukopenia.

4. RENAL INFECTION.

Renal suppuration is usually chronic in its course, but it may appear in such an acute form as to necessitate its consideration here.

The principal varieties of acute renal disease of the suppurative type are:

1. Pyelonephritis.
2. Perinephritis.
3. Pyonephrosis.

1. PYELONEPHRITIS.

There is scarcely any other renal disease which presents such a variety of clinical pictures as pyelonephritis. A description of one group of symptoms would not answer for every case. It is, therefore, most convenient to divide the clinical forms of pyelonephritis, according to the mode of infection, *i. e.*, whether the organisms have reached the kidney through the blood-stream (hematogenous) or through the medium of the ureter (urogenous). This division will suffice for quite a number of cases where the previous history and the examination of the urine will show whether or not the bladder has been the source of infection. There are, however, an equally large number of cases in whom the source of infection is not quite clear, and yet the clinical picture of a renal infection is quite evident. It is so difficult to classify this latter class of cases that it has always seemed advisable to place them in separate groups: Clinically, then, such a division would be as follows:

1. Hematogenous type
   - (*a*) Hyperacute.
   - (*b*) Acute.
   - (*c*) Subacute.
2. Urogenous type
   - (*a*) Recurrent febrile.
   - (*b*) Continuous febrile (chronic u[illegible]

3. Pyelonephritis of children.
4. Pyelonephritis of pregnancy.
5. Pyelonephritis in the puerperium.

1. **Hematogenous Clinical Varieties.**—For many years the view was universally held that renal infections (not including calculous pyonephrosis or renal tuberculosis) were almost always bilateral and the result of a preceding cystitis. For this reason the now obsolete term of surgical kidney was employed to include every clinical variety of the disease. We now know that the source of infection can be recognized from the symptoms and examination as hematogenous in origin, and that in a very large proportion of cases the infection involves only one kidney, and is thus amenable to surgical intervention. Israel, in his book on "Surgery of the Kidney" (published in 1901), was one of the first to call attention to unilateral hematogenous renal infection as a clinical entity. Since that time Brewer and others have described the clinical picture of these cases of acute hematogenous infections of the kidney. The clinical types of the latter are:

(*a*) *The Hyperacute Hematogenous Form.*—The clinical course is usually so rapid and the symptoms of a most virulent infection so marked that any symptoms pointing to the kidney as the source of infection are obscured by the general signs of septicemia. The onset of symptoms is very sudden, usually in persons who have previously enjoyed good health. There is great prostration, high fever (to 106° F.), rapid pulse, marked leukocytosis, vomiting, and often general muscular pains. In some cases there is severe abdominal pain, muscular rigidity and tenderness over the costovertebral angle. When localizing symptoms such as those just mentioned are absent and the examination of the urine is negative, the diagnosis must be one of exclusion.

Differential Diagnosis: The other conditions which must be considered in the differential diagnosis are severe influenza, acute abdominal affections, *e. g.*, perforation of gastric and duodenal ulcers, appendicitis, gallstones, mixed infection in tuberculous kidneys, malaria, and typhoid. Unless the appendix lies behind the cecum or high up near the liver, the differentiation from appendicitis is not difficult. In the latter disease there is more muscular rigidity and tenderness, and pain is a far more prominent symptom. In the case of the retrocecal appendix there is tenderness and pain in the iliocostal space, but there is apt to be more muscular rigidity and spontaneous pain than in acute renal infection. In many cases examination of the urine will be of great aid in distinguishing the two conditions.

In acute cholecystitis the pain is more superficial and nearer the

costal arch. Muscular rigidity is most marked in the right hypochondrium and tenderness on palpation more marked there than in the iliocostal angle. The differentiation of the other conditions named usually presents no difficulties.

(*b*) *Acute Hematogenous Form.*—The clinical picture in the less acute or intermediary (Brewer) hematogenous forms of infection differs but little from that of the acute urogenous type. The chief difference lies in the fact that the symptoms in the hematogenous type begin either after one of the acute infectious diseases or soon after a septic focus, such as a carbuncle, etc., has appeared in some other part of the body. In the urogenous form there is often the history of a preceding cystitis or there are evidences of the presence of obstruction in the urinary tract, either in the form of a valve, stricture or stone in the ureter, or of an enlarged prostate, or calculi obstructing the urethra.

In these acute cases there is the history of a sudden onset of fever, often accompanied by chills. The temperature is irregular and often persistently high, and is accompanied by all the other evidences of a severe infection. Fortunately the localizing signs in both the acute and subacute forms are more marked than in the hyperacute. There is usually some tenderness over the iliocostal angle and often muscular rigidity here. The urine usually contains a small amount of pus.

(*c*) *Subacute Hematogenous Form.*—In this third form of hematogenous renal infection the principal symptoms are long-continued fever of an irregular character accompanied by unilateral costo-vertebral tenderness. Urinary findings are more constant in acute and very mild forms than in the hyperacute. Pus, blood, casts, and albumin are present in the majority of cases. The diagnosis in this mild class is made by a thorough examination, so as to exclude any other source of fever, taken in conjunction with the presence of costo-vertebral tenderness and urinary changes.

2. **Urogenous Clinical Varieties.**—(*a*) Recurrent febrile urogenous type. The symptoms of this form are quite similar to those of the hematogenous mild form just described. The history differs somewhat in two points. First, there is often a preceding cystitis. Such a patient will suddenly have one or more chills followed by high temperature and profuse sweats. This syndrome will last several days to a week, and then the temperature will become normal or slightly above for a variable period. A second attack of chills, fever, and sweats will occur as unexpectedly as the first, and the same cycle will repeat itself a number of times.

The diagnosis in these cases presents no difficulties if one will examine the urine for pus, blood, and casts, which are almost invariably found.

The amount of pus is always larger just after the cycle just described, since it is the retention of this pus in the kidney which causes the recurrent febrile attacks.

3. **Pyelonephritis during Infancy and Childhood.**—This form only differs from those just described by the fact that it is a frequent cause of obscure fever in infants and young children, and as such deserves special mention. Dr. I. A. Abt has reported 22 cases of cystopyelitis, and calls attention to it as a cause of persistent temperature in children accompanied by rapid pulse and progressive pallor and emaciation. The fever is frequently interpreted as due to an intestinal intoxication, and unless a pyelonephritis is borne in mind as one of the causes of obscure fever during early life, the diagnosis will either not be made at all or the condition will be recognized too late to be of any benefit. The mode of infection in the majority of these cases is undoubtedly through the blood-stream, and the source or atrium for the organisms to enter the circulation is in the intestine. The acute febrile form with the clinical picture of a severe sepsis, ushered in by chills, high fever, etc., does not occur nearly as often in children as in adults. An examination of the urine should be made in every case of continued or remittent fever in children where no other cause can be found.

4. **Pyelonephritis during Pregnancy.**—The symptoms of renal infection occurring during this period differ but little from the description of the clinical picture in males and in the non-pregnant female. The only reason for describing it separately here is to call attention to the fact that when it does occur during pregnancy, the possibility of renal infection is seldom taken into consideration in making a diagnosis of the cause of either a continuous fever or of chills and fever, which occur without warning.

A recent case of the writer's will serve to illustrate many of the important points. During the fifth month of her pregnancy a patient who had previously enjoyed the best of health had a chill followed by a temperature of 105° F. accompanied by rapid pulse, great prostration, high leukocyte count, and scanty urine containing much pus. The temperature dropped to normal within a few hours, but the same cycle of chill, fever, and sweat recurred at irregular intervals during the following four days. The case was seen by the writer in consultation upon the fourth day of the illness. Palpation of the abdomen failed to show any localized muscular rigidity or tenderness over the right iliac region. One could make deep pressure over all parts of the abdomen, but there was sensitiveness except upon bimanual palpation of the right kidney, and here it was only of moderate degree. Examination of the genitalia was

negative. One could thus exclude appendicitis, cholecystitis, or any form of genital infection. The possibility of such a sudden onset during pregnancy, of chills, fever, etc. even without vesical symptoms, was recalled, and after appropriate non-operative measures were instituted, the patient made a prompt recovery. Pregnancy proceeded without further incident and ended in a normal manner.

This case illustrates one of the two clinical pictures under which renal infections can occur both during pregnancy and in the puerperium. In the second form the disease may pursue a more chronic course. There is general feeling of malaise, accompanied by muscular pains, fatigue, and a fever of varying degree. It is the persistence of this temperature which first directs attention to this second class of cases. Bladder symptoms, as in the more acute form, may be entirely absent or very slight. In the chronic form the presence of pus in the urine is a more constant finding—because the infection is usually the result of the ascending type, *i. e.*, from the bladder—than in the acute form. Tenderness over this kidney or ureter is seldom sufficiently marked in these more protracted cases to be of value in making a diagnosis. When the outflow of pus from the kidney is not obstructed, there is but little fever, but this recurs promptly when there is any retention. The use of the cystoscope is seldom necessary, since the diagnosis in both of the above classes of cases can be made by excluding any other source for the fever than the kidney.

In the majority of cases the pyelonephritis is upon the right side. This is due to the fact that although both ureters are compressed by the uterus during pregnancy, the right ureter is more compressed than the left as the result of the rotation of the uterus on its long axis from left to right and the greater frequency of positions in the right oblique diameter. The most frequent abdominal conditions which begin so acutely are cholecystitis, stones in the common duct, and appendicitis. These can be readily excluded by the absence of localized muscular rigidity and tenderness over the respective areas and the fact that high fever preceded by chills is only characteristic of common-duct stones.

5. **Pyelonephritis in the Puerperium.**—This, like the similar condition in pregnancy, may begin very suddenly without prodromal symptoms like those of a cystitis. In the majority of cases the source of the infection is in all probability, the bladder. In only a small number is the infection a descending, *i. e.*, hematogeneous one. The patient may have made an excellent recovery from the parturition with normal temperature, pulse, and lochia. Then suddenly she has a chill, followed

by high fever, rapid pulse, and a marked leukocytosis. The fever either persists or recurs irregularly following a chill.

In some cases there is marked pain over the affected kidney (in the lumbar region) and along the ureter. In others there are absolutely no localizing symptoms referable to the kidney. This syndrome may occur during the first few days or several weeks after parturition. Pus in a variable quantity is usually present in the urine, and in some cases there is vesical tenesmus and pain on micturition, but the latter two symptoms are not constant. The diagnosis in these cases must be made by excluding any of the puerperal pelvic complications following infection during or soon after parturition. If the pelvic examination yields negative results, an infection of the kidney should always be thought of as a frequent cause of fever during the puerperium. The clinical picture just described of a sudden onset with chill, fever, etc., does not fit all cases. In some the only symptom to attract the physician's attention is a rise in temperature, especially toward evening, for which no cause can be found in the genitalia. Palpation of the kidney in both of the above types often reveals considerable tenderness, especially on bimanual palpation. The organism which causes the pyelonephritis is the colon bacillus, and the starting-point is without doubt an intestinal infection, especially in those cases in which any instrumental infection of the bladder can be excluded.

2. PERINEPHRITIS.

In this affection there is pain in the lumbar region, at times radiating into the thigh or testes. The pain is usually quite severe, and the corresponding renal region is very tender, rigid, and often edematous. These local signs are accompanied by evidences of deep-seated suppuration, such as chills, fever, furred tongue, vomiting, stupor, and even delirium. There is often a peculiar lameness; the patient walks with the body bent forward and inclined to the affected side, the thigh being held flexed.

The urine may be normal if the disease be of extraneous origin, or it may contain blood if it follow an injury, or, finally, in a few cases there is pus in the acid urine.

Differential Diagnosis.—1. *Lumbago* is but rarely accompanied by fever or leukocytosis. The pain is most often bilateral and does not radiate to the testis or thigh.

2. *Spondylitis.*—The pain extends around the body; it is relieved by suspending the patient. The tenderness is over the spine itself, which is held in a rigid manner, best seen when the patient is asked to

bend forward. There is also but little fever or leukocytosis and the symptoms are more gradual in their onset.

3. *Hip-joint Disease.*—The pain and tenderness are lower down, often referred to the knee. There is limitation of motion at the hip, and when the limb is straightened there is marked lordosis of the lumbar spine. The *x*-ray often shows a pathologic head of the femur.

4. *Appendicitis.*—In those cases in which the appendix is directed down or inward (Fig. 201) the pain is in the right iliac fossa and followed by nausea and vomiting. In perinephritis the pain and swelling are higher up in the iliocostal space. In inflammation in an appendix which lies behind the cecum and ascending colon with its tip directed upward, the rigidity of the abdominal wall, tenderness, and pain may greatly resemble those of a right-sided perinephritis. In appendicitis, however, the pain is usually followed by nausea and vomiting. The rigidity and swelling, etc., of a perinephritis usually extend further back in the iliocostal space.

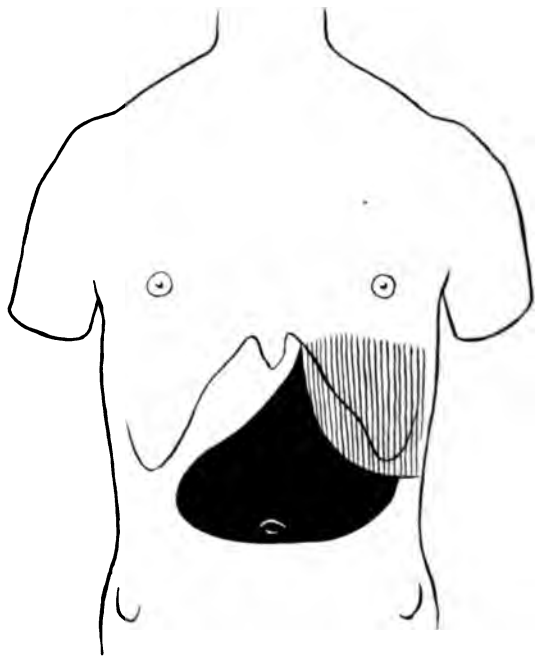

FIG. 190.—AREA OF DULLNESS IN LEFT-SIDED SUBPHRENIC ABSCESS. The dark area shows absolute dullness, the area indicated by vertical lines corresponds to the zone of tympany (A. Martin).

3. PYONEPHROSIS.

This affection is not apt to run an acute course. The enlarged kidney can usually be distinctly felt as greatly enlarged, there is no rigidity of the abdominal muscles, no edema of the skin, and there is a history of long duration of the symptoms. In some cases there is a previous history of an obstinate lumbago which was never properly

FIG. 191.—SEPTIC PYELONEPHRITIS (OF THE UROGENOUS TYPE).

1, Congested portion of ureter; 2, pelvis of kidney covered with pus and granulation tissue; 3, view of cortex in section, showing the streaky appearance given by the yellowish pus foci to the cortex and medulla; 4, similar areas in cortex; 5, view of convex or outer surface of kidney, showing the multiple suppurative foci which occur in groups, with reddish periphery and raised above the level of the surrounding normal cortical tissue; 6, this number is placed in the center of a few isolated miliary abscesses, the yellowish color of which stands out in contrast to that of the lighter shade of the normal cortex.

diagnosed as of renal origin. In other cases there is a history of attacks of renal colic.

5. SUBPHRENIC ABSCESS.

(See Figs. 190 and 192.)

This condition if situated in the right subphrenic space most frequently follows appendicitis, and perforations of the stomach or duodenum, if located in the left subphrenic space. It may, however, occasionally

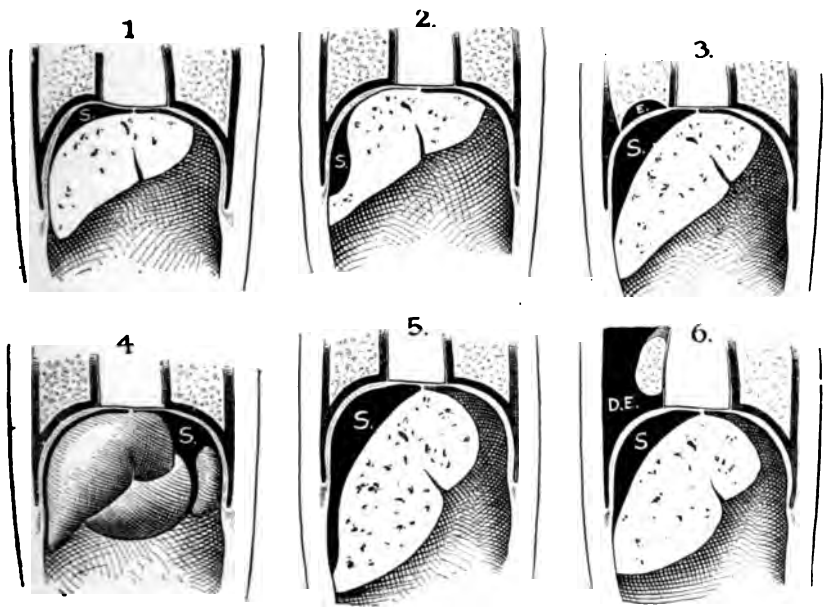

FIG. 192.—VARIOUS FORMS OF SUBPHRENIC ABSCESSES COMPLICATING APPENDICITIS.

S., in all of the figures, represents the abscess. E., in 3, represents empyema. D. E., in 6, diffuse empyema. 1. Abscess beneath dome of diaphragm. 2. Abscess low down in subphrenic space. 3. Combination of encapsulated diaphragmatic empyema and subphrenic abscess. 4. Left-sided subphrenic abscess. 5. Large abscess occupying entire right subphrenic space. 6. Combination of right subphrenic abscess and non-encapsulated empyema.

occur in the latter locality after an acute appendicitis. The attack of appendicitis need not have been complicated by pus formation and the subphrenic abscess may follow days to months after the primary attack.

The history of a sudden occurrence of fever and of other signs of suppuration, such as leukocytosis, etc., toward the end of or shortly after an attack of appendicitis associated with pain in the right or left hepatic region, should lead to a search for a subphrenic ab-

scess. In the case of the left-sided abscesses following gastric or duodenal ulcer there is a previous history of pain in the epigastrium and of vomiting of blood, or of copious tarry stools followed by the symptoms of infection.

The diagnosis must be based on the physical signs and the general evidence of deep-seated infection, such as fever, rapid pulse, leukocytosis, etc., aided by exploratory puncture, which is the most valuable aid in making a diagnosis.

FIG. 193.—AREA OF COMBINED LIVER AND SUBPHRENIC ABSCESS DULLNESS IN A CASE OF RIGHT-SIDED ABSCESS.

In right-sided subphrenic abscesses the liver is usually pushed downward. Over the abscess there is a continuation upward of liver dullness for a variable distance with a corresponding suppression of pulmonary sounds. A subphrenic abscess may cause a horizontal line of dullness or one that is convex upward. The area of dullness may be more marked at some one point, thus resembling an encapsulated empyema. If gas is present in the abscess, dullness is replaced by tympany and there are succussion sounds, as in pyopneumothorax.

The pain may be strictly localized over the right or left hypochondriac regions or may be diffuse, and not infrequently there is tenderness and rigidity, rarely edema of the overlying tissues.

The intraperitoneal form is much more common, and is usually on the right side, but six left-sided cases have been reported. Subphrenic abscess may follow appendicitis when there has been no suppuration about the appendix, and it is often impossible to trace any purulent tract between the abscess and the appendix. It rarely occurs as the result of a general suppurative peritonitis. In the majority of cases the appendix

is retrocecal or there is a persistence of the embryonal position of the appendix, due to non-rotation of the cecum thus bringing it in close contact with the right lobe of the liver; and favoring the formation of a subphrenic abscess. In the acute form the pain, nausea, and other signs of an acute infection are not always marked; the persistence of a high temperature, with or without accompanying signs of septic infection, is the most characteristic symptom. In some cases physical signs will be of the greatest aid while in others exploratory puncture is the most valuable aid in the diagnosis. Subphrenic abscess may also occur in a subacute form, the symptoms first manifesting themselves a week or

FIG. 194.—PERIDIVERTICULITIS WITH GREAT THICKENING OF THE GUT WALL, CAUSING STENOSIS AND SIMULATING CARCINOMA FOR WHICH IT WAS MISTAKEN WHEN RESECTED AT OPERATION. (From drawing kindly loaned by W. H. Maxwell Telling, of Leeds, England.)

The thickening due to fibrosis is seen at *a*.

more after the operation or attack; or in a chronic form with indefinite symptoms for weeks or months, or with the sudden late appearance of acute septic symptoms from an obscure deep-seated focus. If a patient who gives a history of probable appendiceal trouble or who has been operated on for appendicitis has a continuous rise of temperature, accompanied by other signs of septic intoxication, one should always search carefully for subphrenic abscess. The downward displacement of the liver, the presence of an area of dullness with a convex upper border, continuous with the liver dullness, and the finding of fetid pus by exploratory puncture, are very characteristic.

Differential Diagnosis.—*Empyema.*—This is at times very difficult. Rapid respiration, cough, expectoration, and the history of a preceding pneumonia speak for empyema. The line of dullness in the diffuse form is said to be concave upward, but this may occur in subphrenic abscess as well. Between an encapsulated empyema close to the diaphragm and a subphrenic abscess, differentiation is impossible. The physical signs for both empyema and subphrenic abscess are so nearly alike that greater reliance should be placed on the etiology and character of the pus obtained by exploratory aspiration. The latter is apt to have the peculiar acid fetor of colon bacillus pus, while in empyema there is seldom any odor. Again, in subphrenic abscess the exploratory puncture reveals the presence of pus at a lower level than in empyema.

FIG. 105.—DIVERTICULA OF SIGMOID. (From drawing kindly loaned by W. H. Maxwell Telling, of Leeds, England.)

The fat has been partly dissected from off the outer surface of the gut showing several pouches. At *a* is seen a larger one containing a calcareous concretion with a thin fibrous pedicle in the process of separation to form a loose peritoneal body. A similar concretion, the size of a bean, was free in the pelvis.

Abscess of the Liver.—Here the history of a preceding attack of dysentery and the less marked extension of the liver dullness upward are of value. In multiple abscesses of the liver following appendicitis there is greater evidence of sepsis and more general enlargement and tenderness of the liver.

6. SUPPURATING ECHINOCOCCUS CYSTS OF THE LIVER.

These may present the same symptoms and local findings as single or tropical abscesses. There is, however, no history of dysentery, and the occupation of the patient frequently is suggestive in that the disease is much more common in those brought in close contact with sheep and sheep-dogs. In the absence of a distinct tumor and the history or evidence of the presence of similar cysts elsewhere, a recognition of this condition is impossible. When the tumor is distinct, as is often the case, aspiration will frequently show hooklets.

7. DIVERTICULITIS.

This interesting form of left-sided inflammation is the result of pathologic changes, which take place in or around diverticula of the sigmoid flexure. Such diverticula or finger-like projections from the lumen of the sigmoid most frequently occur in elderly people, but they may be found at all ages. There are a number of clinical forms in which this

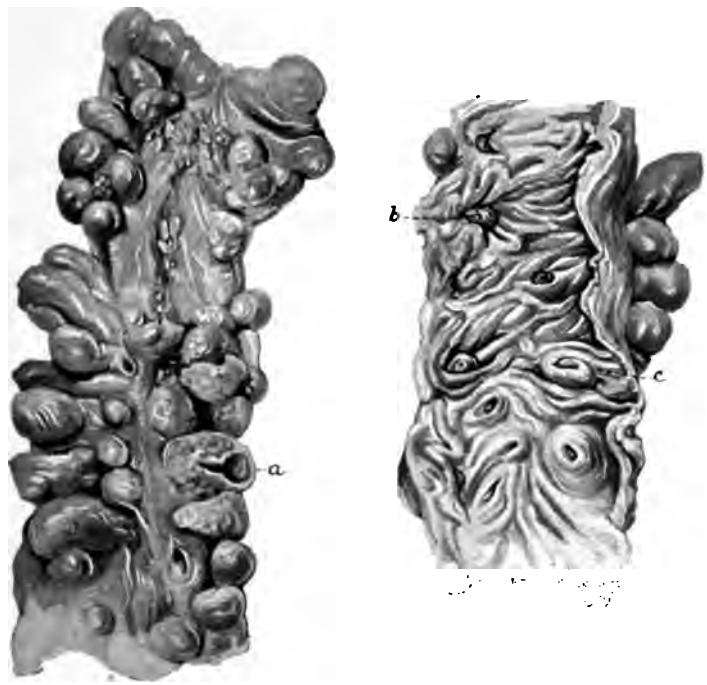

FIG. 196.—DIVERTICULA OF SIGMOID. (From drawing kindly loaned by W. H. Maxwell Telling, of Leeds, England.)

A, The fat has been dissected from off the outer aspect of the bowel. The pouches are for the most part into the appendices epiploicæ. One of the sacs is laid open at *a*. B, Inner surface of the bowel from the same specimen. A concretion is seen at *b* presenting at the orifice of one of the diverticula. At *c*, the lipped orifice is well seen.

condition called diverticulitis can occur: (*a*) A mild inflammation of one or more diverticula, similar in its pathology to an acute catarrhal appendicitis. (*b*) An empyema or gangrenous inflammation of a diverticulum, with or without an accompanying fecal concretion lying in the diverticulum. (*c*) A perforation of a diverticulum with the formation of an encapsulated intraperitoneal abscess. (*d*) Perforation of a diverticulum

and escape of the contents into the free peritoneal cavity, with development of a general peritonitis.

The above forms will be seen to bear great resemblance to the various pathologic and clinical forms of appendicitis. The analogy, however, ends here, since certain further pathologic changes occur in diverticulitis which do not occur in appendicitis. These further forms are (*a*) the formation of fistulæ between the diverticulum and the bladder or a coil of small intestine, and (*b*) the development of a hyperplastic inflammation

FIG. 197.—SIGMOID SHOWING DIVERTICULA. (From drawing kindly loaned by W. H. Maxwell Telling, of Leeds, England.)

Inner aspect of gut. Normal but rugose mucosa. The orifices show well-marked lipping and concretions protruding partially from some of the pouches.

in the vicinity of the diverticulum to such a degree as to resemble a neoplasm in many cases. The symptoms of the first four forms which resemble appendiceal inflammation only differ from the various clinical forms of appendicitis in being located upon the left side. In the varieties with acute inflammation or where localized intraperitoneal suppuration occur, there is more or less colicky pain in the left iliac or hypogastric regions, accompanied by fever, leukocytosis, muscular rigidity, and tenderness on palpation. The gradual formation of a tumor in the left lower abdominal quadrant confirms the diagnosis. If low down

in the pelvis, it may be impossible to distinguish the condition in the female from an infection of the left tube or ovary. The development of a general peritonitis occurs with the same clinical signs as after perforation of any viscus (see page 273). The form resembling a carcinoma is discussed on page 353, under the head of chronic conditions causing symptoms of stenosis of the intestine.

FIG. 198.—DIVERTICULA OF SIGMOID SHOWING ENTEROLITIS *in situ*. (From drawing kindly loaned by W. H. Maxwell Telling, of Leeds, England.)

[1] The abundant fat has been dissected from off one-half of the bowel showing the pouches which entered the appendices epiploicæ. At *a* a single pouch has been dissected out and shows well how they are buried in fat and liable to pass unrecognized unless specially sought for; *b*, longitudinal muscular band; *c* a concretion.

8. MULTIPLE ABSCESSES OF THE OMENTUM.

This condition may follow abdominal operations, especially those for radical cure of hernia. The clinical history, as observed in one such case by the author, was the following :

Severe pain in that side of the abdomen upon which the herniotomy

wound was situated, with rigidity and tenderness. The temperature varied between 101° and 104° F., there was considerable abdominal distention, some vomiting, and constipation.

A distinct tumor could be felt extending from Poupart's ligament toward the umbilicus. The greatly thickened omentum in these cases contains a number of small abscesses.

The diagnosis depends upon the signs of localized peritonitis with formation of tumor, following an operation.

FIG. 199.—CHRONIC PERIDIVERTICULITIS, WITH THICKENING AND STENOSIS OF THE GUT WALL SIMULATING CARCINOMA. (From drawing kindly loaned by W. H. Maxwell Telling, of Leeds, England.)

There was adhesion to the small intestine causing chronic obstruction and to the bladder. There were several small chronic abscesses in the neighborhood, the largest between the bowel and the bladder. The thickening of the gut is seen at *b*. The rod is inserted into a diverticulum.

GROUP II.—PAIN A PROMINENT EARLY SYMPTOM.

In this group all of those acute conditions are included in which the chief symptom is pain. This is accompanied by other signs of involvement of the abdominal viscera. In many of the conditions the pain can be localized fairly well from the onset; in others, such as appendicitis, it is often diffuse at first, becoming more definite in the course of a few hours.

1. APPENDICITIS.

Diagnosis.—In every case of acute appendicitis the diagnosis may be made from an almost constant triad of symptoms:

1. Pain of a sudden, severe, often colicky nature.
2. Nausea and vomiting.
3. Localized tenderness and muscular rigidity.

1. *Pain.*—This is often general at first, but soon becomes localized, in the majority of cases, in the right iliac region. The only exceptions to this rule are:

(*a*) When the appendix is directed upward toward the liver, and especially when it lies behind the ascending colon (Fig. 201), the pain may be referred to the lumbar or right hypochondriac regions.

(*b*) When the appendix points inward or toward the pelvis, the pain is referred either to the umbilicus or to the left iliac region (Fig. 200), and is often accompanied by vesical and rectal symptoms.

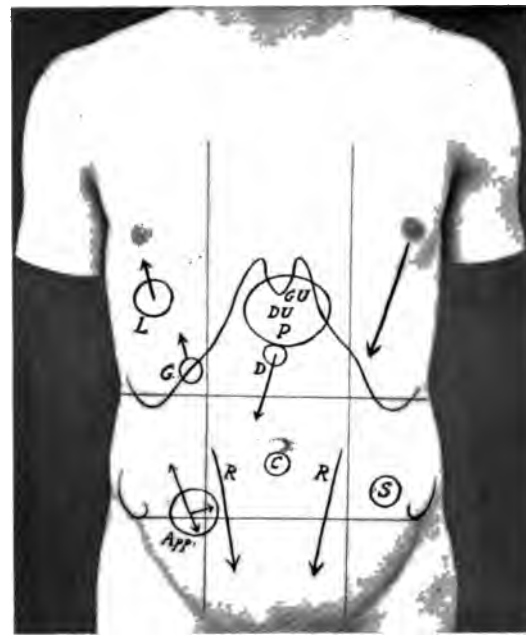

FIG. 200.—MOST FREQUENT DIRECTION OF RADIATION OF PAIN IN VARIOUS ACUTE ABDOMINAL AFFECTIONS.

L and *G*. Gallbladder and hepatic affections; *GU*, and *DU*, and *P*, location of pain in gastric and duodenal ulcers and pancreatic affections; *D*, occasional radiation of pain in duodenal ulcers to right iliac region; *C*, location of pain in ordinary intestinal colics, and in early stages of acute appendicitis; *App*, various radiations of pain in appendiceal inflammation; *R*, radiation of pain in ureteral and renal conditions, along the line of the ureter toward the bladder, testes, and thighs; *S*, location of pain in sigmoiditis, and affections of the descending colon. The arrow pointing downward and inward from the left nipple is to indicate the frequent reference of pain in thoracic affections, to the abdomen.

2. *Vomiting.*—This accompanies the pain as a primary symptom or follows it after three or four hours.

If the nausea and vomiting persist or reappear at a later period, *they are danger-signals of a beginning peritonitis* (see page 276).

3. ***Tenderness and** Muscular Rigidity.*—As a rule, these are most

marked over the right iliac region and are best elicited when the shoulders are raised and the thighs flexed (Fig. 202). The tenderness in the acute cases is quite superficial and manifests itself when the slightest pressure is made. Deep tenderness can be found only with difficulty during the acute stage, owing to the muscular rigidity. The examination should never be forcible. A good plan is to have the patient palpate the abdomen gently with the index-finger and ask him to locate the most tender point. Often the most marked tenderness can be obtained by rectal or vaginal examination. The rectal method is especially of value in children, where the appendix so often points toward the pelvis and abscess formation in the pelvis is so common. In advanced cases one can feel a bulging along the anterior wall of the rectum.

FIG. 201.—NORMAL POSITIONS OF VERMIFORM APPENDIX.

1, Pointing downward and inward toward the pelvis; 2, pointing inward and to the left; 3, pointing upward toward the liver, and lying either in front or behind the cecum. *G*, Normal location of gallbladder; *Sp*, spleen; *L*, liver; the letter itself is placed on the left lobe.

The abdominal rigidity, being due to a reflex muscular contraction, is a very valuable sign when it accompanies pain, vomiting, and localized tenderness. This symptom is best obtained by gradually and lightly sliding the hand over the suspected region.

If the appendix lies in either of the unusual positions referred to above, the tenderness and rigidity are correspondingly altered in location (Fig. 204). If the cecum has failed to rotate, all of the local signs of appendicitis (pain, muscular rigidity, and tenderness) are found above the level of the umbilicus on the right of the median line (Fig. 205). If the appendix lies across the abdomen and ends in the left iliac region,

the local signs are all to the left of the median line and below the level of the umbilicus (Fig. 211).

Pulse.—In the majority of cases there will be an increase in the pulse-rate with the onset of pain. The rate may be from 80 to 100 for a number of hours. *If it shows a gradual increase in frequency after the first twelve hours it is, as a rule, an ominous sign.* The steady rise of the pulse-rate to 110, later to 120 or higher, especially if it is jerky in

FIG. 202.—CORRECT METHOD OF EXAMINATION OF THE APPENDIX REGION, WITH THE LIMBS FLEXED UPON THE ABDOMEN.

The limbs should be raised to such a height that the soles of the feet can rest easily on the bed or table. The patient's back should be somewhat elevated, and he or she should be instructed to relax the abdominal muscles by diverting his attention or asking them to open the mouth. Pressure is then made along the right border of the right rectus, with the entire palmar surface of all of the fingers of the right hand, and not with the tips of these fingers.

character, is of great value in the diagnosis of a beginning peritonitis, especially if nausea continues, or vomiting is repeated and the area of rigidity and tenderness increase and are combined with abdominal distention. In children, the pulse-rate is relatively much higher than in adults and a rapid pulse is not always to be relied upon.

Fortunately for the purpose of diagnosis a slow pulse is but rarely met with. The author recalls a pulse of 66 and a temperature of 99.6° in a case of extensive spreading peritonitis following appendicitis.

The muscular rigidity, tenderness, and tympanites were so characteristic that a diagnosis could be made from these symptoms alone.

Temperature.—A rise in temperature usually occurs within two to three hours after the beginning of an attack. In the milder catarrhal cases it is not higher than 100° or 101° F., but even this is inconstant. If fever persists and increases gradually during the first forty-eight to seventy-two hours, it generally means an encapsulated abscess. If the temperature drops suddenly, especially if accompanied by a rise of pulse-rate and increase of rigidity, it is significant of gangrene or of a

FIG. 203.—METHOD OF PALPATING THE APPENDIX WITH THE LIMBS OUTSTRETCHED.

The fingers are laid flat upon the abdominal wall, the examiner standing to the right of the patient. Either the right or left hand may be used. The appendix may usually be felt on the outer edge of the right rectus muscle if enlarged, and if the abdominal walls are relaxed. Palpation should be carried out with as large a surface of the fingers as possible, and not by prodding the patient's abdomen with the finger-tips. This method is not as good as that shown in Fig. 202.

beginning peritonitis. Persistent temperature or fever occurring after apparent recovery, signifies some complication like pylephlebitis or subphrenic abscess. *The most accurate temperatures are those taken per rectum.*

Leukocytosis.—Catarrhal appendicitis is accompanied by a mild degree of leukocytosis, rarely above 12,000. An increasing leukocytosis, from 15,000 upward, generally indicates a severe infection. In some cases of severe catarrhal appendicitis one may find a count of 25,000 to 30,000. If the count remains stationary, it is indicative of a walling off.

If the leukocyte count decreases gradually in a mild attack, it signifies improvement. If it decreases suddenly after a severe attack, it signifies either gangrene, perforation with beginning peritonitis, or the rupture of an abscess into the general peritoneal cavity. The majority of cases in which perforation or gangrene occurs early, and causes peritonitis, have a low leukocyte count, owing to the lack of resistance on the part of the organism and the overwhelming of the system by the toxins.

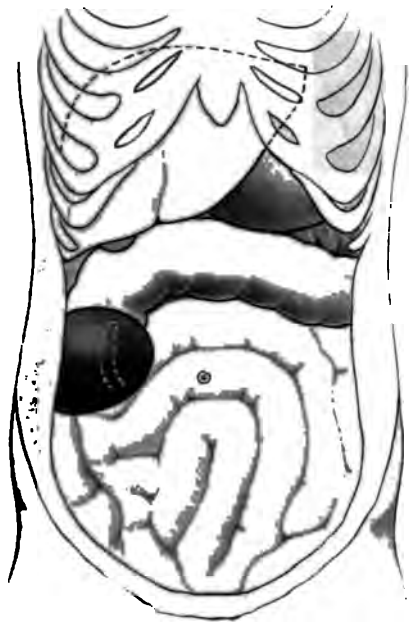

FIG. 204.—APPENDICAL ABSCESS.

High position of cecum opposite umbilicus with appendix and nonrotated cecum at that level.

FIG. 205.—APPENDICAL ABSCESS.

Subphrenic abscess due to malposition of appendix and faulty rotation of cecum. Appendix pointing directly into subphrenic space.

Tumor.—As an early sign this is of little value, owing to the fact that the muscular rigidity is so marked in many cases that deep palpation is both difficult and dangerous. In other cases the contracted edge of the rectus is apt to feel like an inflammatory mass. Again there are cases where the omentum wraps itself around the appendix and forms a palpable tumor. When the acute symptoms have subsided, a tumor can often be felt through the less rigid muscles. Rectal examination should never be omitted, especially in children, where the pelvis is shallow and the appendix is more apt to be located in it.

Hematuria.—Attention has been called by Seelig[1] and others to a class of cases in which blood in the urine and pain in the kidney or ureter was a prominent symptom of the attack of acute appendicitis. In many of the cases this hematuria is the result of a toxic nephritis. In others, the ureter is kinked by an inflamed appendix, while in a third class there is an inflammatory condition of the kidney due to an adjacent inflamed appendix.

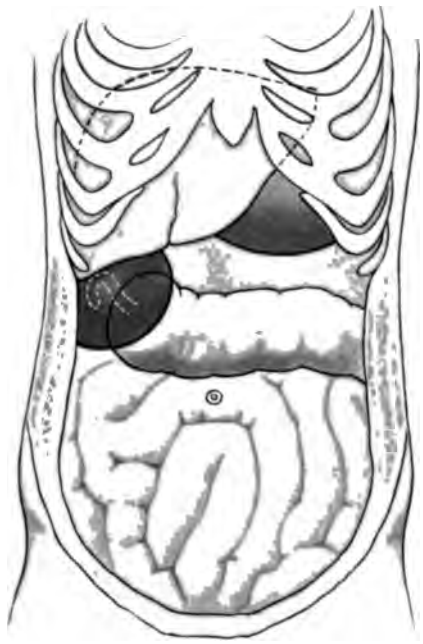

FIG. 206.—APPENDICEAL ABSCESS.
Subhepatic appendiceal abscess due to nonrotation of cecum. Appendix pointing upward toward liver.

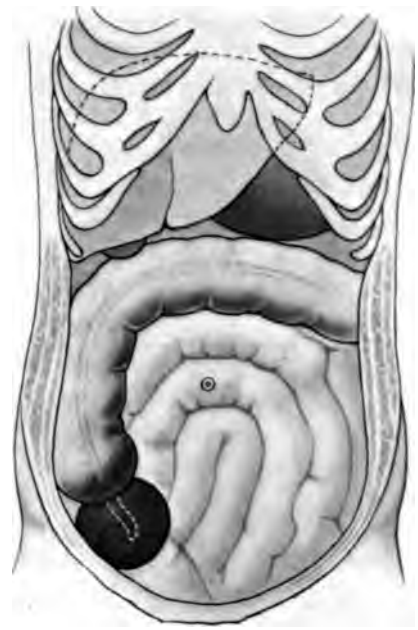

FIG. 207.—APPENDICEAL ABSCESS.
Most frequent variety. Appendix points down and inward. Abscess just above pelvic brim in iliac fossa.

Differential Diagnosis.—*Acute Gastro-enteritis.*—In these, as in appendicitis, there is often a history of indiscretion in diet, followed by abdominal pain and vomiting. In acute gastroduodenal catarrh the pain is felt over the epigastrium and is never as severe or colicky as in appendicitis. The nausea and vomiting are far more marked early symptoms, and may be almost constant. There is no true muscular rigidity and but slight, if any, tenderness. In an acute enterocolitis the pain may be as severe as in appendicitis, but is usually referred to the umbilicus and does not become more intense, as it does in appendicitis.

[1] "Annals of Surgery," vol. xlviii, p. 389.

FIG. 208.—A, SPECIMEN OF AN APPENDIX SHOWING VARIOUS STAGES OF PATHOLOGIC CHANGES.

1, Gangrene of the mucous membrane; 2, marked catarrhal inflammation of the mucous membrane; 3, cicatricial obliteration of the lumen of the appendix (appendicitis obliterans); 4, greatly thickened muscular and serous coats; 5, inflamed fat of mesenteriolum.

B, GANGRENE OF ALL OF THE WALLS OF AN APPENDIX CONTAINING TWO LARGE ENTEROLITHS.

There is also no localized rigidity or tenderness and the attack often subsides as soon as an enema is given, while in appendicitis the symptoms become more marked from hour to hour. It must not be forgotten that an appendicitis may often accompany an enterocolitis.

In some cases of intestinal colic there is accompanying vomiting, diarrhea, and flatulency. There is an absence of any local rigidity and tenderness and the pains, if present, are more diffuse.

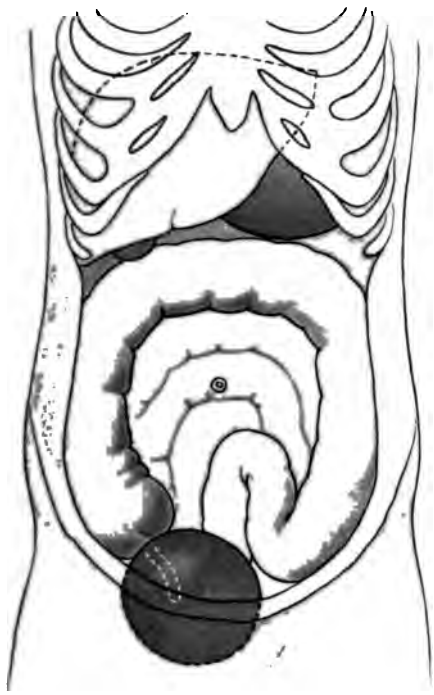

FIG. 209.—APPENDICAL ABSCESS.

Appendix pointing down and inward. Abscess located in pelvis. A frequent form in children. Bulging of anterior wall of rectum often to be distinctly felt.

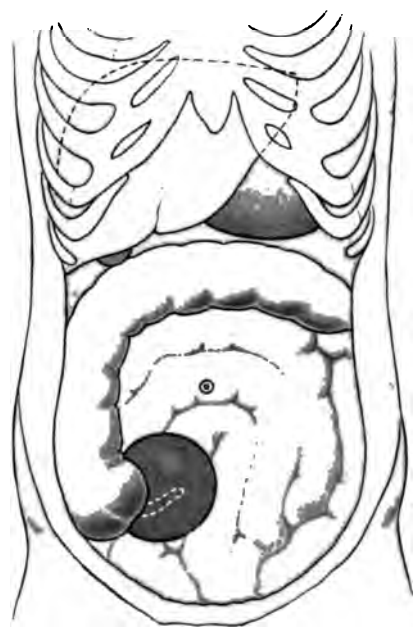

FIG. 210.—APPENDICAL ABSCESS.

One of most frequent locations of the abscess between agglutinated coils of intestines and cecum. Appendix points inward.

Intestinal Obstruction.—In the first twenty-four to forty-eight hours there is no difficulty in distinguishing this condition from appendicitis. When, however, peritonitis has begun and caused a septic paralysis of the intestines, it is impossible to distinguish them, except from the history.

In intestinal obstruction, if there is any localized pain, it is referred to the umbilicus. A systematic examination of the hernial openings often reveals the cause of the obstruction. Volvulus pains are referred

to the left side of the abdomen and early distention of this half of the abdomen is most marked. Obstruction from volvulus, tumors, and bands is more common in adults. In children, intussusception is more frequent, and a tumor can often be felt per rectum or in the iliac fossæ, and blood and mucus are passed per rectum. In obstruction the pulse is but little higher than normal until peritonitis occurs, while in appendicitis there is a gradual rise of pulse and temperature from the beginning. The early nausea and vomiting of obstruction recur so frequently as to become the most prominent symptom. The bowels cannot be moved nor can flatus be passed, and the abdominal distention occurs in greater degree, as well as much earlier, than in appendicitis. In appendicitis vomiting occurs quite early, is never stercoraceous, does not recur until peritonitis sets in, and constipation is never absolute. In intestinal obstruction the abdominal wall is soft for the first forty-eight hours.

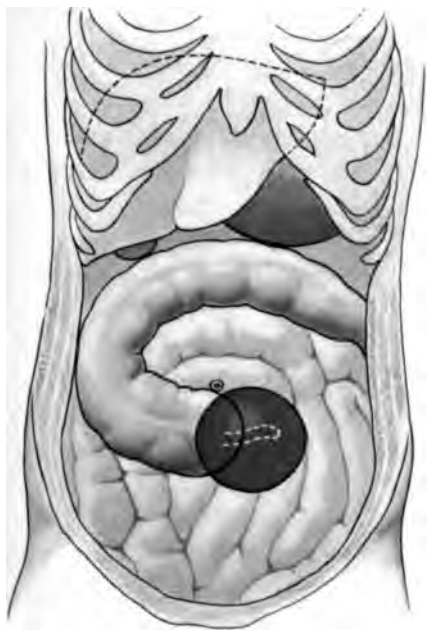

FIG. 211.— APPENDICEAL ABSCESS.
Appendix and cecum drawn toward left side of median line.

Typhoid Fever.—According to R. S. Fowler,[1] four clinical types occur: (*a*) Appendicitis preceding typhoid by seven to ten days. (*b*) True typhoidal appendicitis occurring at the outset of typhoid and rapidly followed by indubitable signs of typhoid. (*c*) Appendicitis may complicate typhoid at any time. (*d*) It may follow typhoid after several months. In the first two weeks of certain cases of typhoid there is rigidity and tenderness of the right iliac region, accompanied by fever. In the absence of a good previous history such cases are apt to impress one as being an appendicitis. As a rule, however, a differentiation is possible. The pain and rigidity are never as marked in typhoid as in appendicitis; the pulse is out of proportion too, being much slower than in appendicitis. In addition, there is a leukocytosis in appendicitis and a leukopenia in

[1] "Long Island Medical Journal," Jan., 1907.

typhoid. The Widal reaction is characteristic of typhoid and is absent in appendicitis unless the patient has had a previous attack of typhoid. If a history can be obtained, it reveals the fact that the disease has been gradual in onset, accompanied by headache, backache, lassitude, and often by epistaxis. The enlargement of the spleen and the steady rise of temperature with a relatively low pulse-rate and finding the typhoid bacillus in the blood by culture methods are characteristic of typhoid.

The differential diagnosis between typhoid perforation and appendicitis is referred to on page 309.

Gastric Ulcer.—This is usually preceded by a history of long-continued pains referred to some particular spot in the epigastrium, occurring several hours after eating, increased by the taking of food and often accompanied by hematemesis or blood in the stool. The majority of gastric ulcers occur in young women who are anemic and have had sedentary occupations. The examination of the stomach contents shows an increased amount of hydrochloric acid.

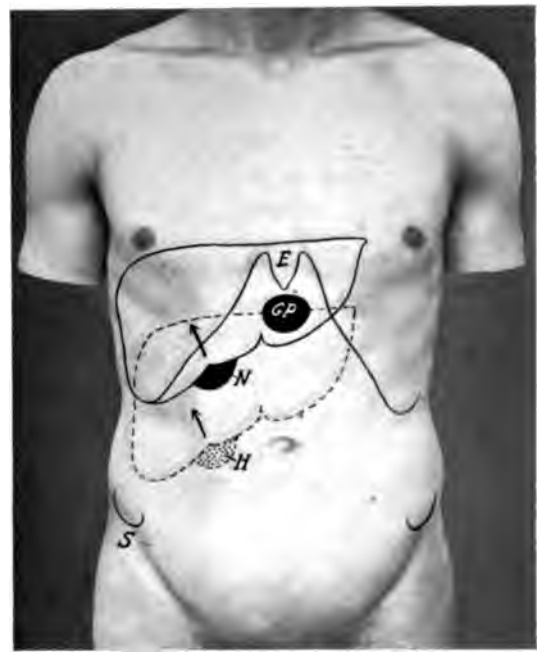

FIG. 212.—LOCALIZED PAIN AND RIGIDITY IN NORMALLY LOCATED AND DISPLACED GALLBLADDER.

N, Normal position of gallbladder and liver; the black arrow indicates the most frequent direction of radiation of pain to the right shoulder; *H*, location of pain, etc., in descended liver; *E*, ensiform process; *GP*, location of pain and rigidity in abscesses of the left lobe of the liver.

Duodenal Ulcer.—There is a history of long duration of pain, occurring in middle-aged people, two or six hours after eating. The pain is felt in the epigastrium, but may be referred to the shoulder or to the right iliac region.

The principal diagnostic points of perforating gastric and duodenal ulcers are discussed on pages 306 and 308. A perforating gastric ulcer can be diagnosed from the previous history, from the

location of the pain, and from the presence of rigidity in the epigastrium. The symptoms of collapse and the increase in pulse-rate are much more marked than in appendicitis. The respiration is rapid and costal in type. In perforating duodenal ulcer, the pain is not so typical in its location and is often referred to the right iliac region, but there is no rigidity in this latter location, as in an appendicitis.

When, after the perforation of a gastric or duodenal ulcer, peritonitis has occurred, and the septic fluid collects in the iliac fossa and pelvis, causing tenderness and rigidity, accompanied by abdominal distention, vomiting, increased pulse-rate, and leukocytosis, a differentiation from appendicitis is impossible before operation, except from the previous history. When a localized peritonitis with abscess formation has occurred after perforation of a gastric or duodenal ulcer, the only means of differentiation from the commoner types of appendiceal abscess, is by the fact that the tenderness, rigidity, and local inflammatory signs are situated nearer the costal arch than in an appendicitis.

Acute Cholecystitis with or without Gallstones.—The pain in this condition, whether due to gallstones or not, is localized in the right upper quadrant, as a rule, rather than in the right lower, as in appendicitis. The pain is usually more cutting in character and radiates to the right shoulder. Muscular rigidity and tenderness are most marked over the junction of the right rectus and the costal arch. There is often also a history of previous attacks, accompanied, in some cases, by slight or marked jaundice (the latter if common-duct calculi are present), or by early and repeated vomiting and chills, if an infection of the bile-passages has existed.

In a few cases, a tumor, corresponding to the gallbladder, can be outlined by both percussion and palpation (Fig. 187).

There are cases, such as those referred to later, where a differentiation between cholecystitis and appendicitis is impossible. These are where the gallbladder is at a lower level than normal. If covered by an elongated Riedel's lobe (Fig. 187), the resistant mass of liver tissue can often be felt through the thin and flabby abdominal walls. Similarly, one can outline a descended liver in some cases (Fig. 212).

If suppuration occurs in the gallbladder (empyema), the rigidity and tenderness are higher up than in appendicitis. However, leukocytosis and the existence of a tender mass in the right upper quadrant may lead to some confusion with appendicitis complicated by abscess formation in an appendix located high up (Fig. 205).

Acute Inflammation of the Female Adnexa.—This can be best understood by a reference to the following table:

Acute Appendicitis.	Acute Salpingoöphoritis.
1. Muscular rigidity marked.	1. But little rigidity.
2. Pain begins at umbilicus and becomes localized over McBurney's point unless appendix points to pelvis.	2. Pain lower down in abdomen just above Poupart's ligament.
3. Tenderness over right iliac fossa.	3. Tenderness low down over pelvis.
4. Pain followed in a few hours by nausea and vomiting.	4. Nausea and vomiting infrequent.
5. Bimanual examination negative unless appendix in pelvis, then tender mass lateral to uterus.	5. Bimanual examination shows tender mass lateral to or behind uterus.
6. No history of gonorrheal infection.	6. Usually history of infection to be obtained.

When acute appendicitis occurs during the course of an acute inflammation of the female pelvic organs, a differentiation is impossible, except that the pain is most intense over McBurney's point.

Other conditions from which appendicitis must be differentiated are:

1. Renal and ureteral colic (page 312).
2. Pyelonephritis and pyonephrosis (page 278).
3. Pelvic inflammatory conditions in women (see above).
4. Acute pancreatitis (page 311).
5. Twisted pedicles of ovarian and uterine tumors (page 315).
6. Abdominal crises due to Meckel's diverticulum (page 321).
7. Torsion of the spermatic cord of a normal or undescended testis (page 316).
8. Inflammation of the intraabdominal portion of the vas deferens (page 319).
9. Embolism and thrombosis of the mesenteric vessels (page 314).
10. Acute pleural or pulmonary inflammation (page 114).
11. Dietl's crises due to the kinking of the ureter in movable kidney (page 313).

Acute Tuberculous Appendicitis.—A number of cases have been reported during recent years of tuberculous infection of the appendix, apparently primary, which present a clinical picture similar to that of the ordinary types of acute appendicitis. The onset in these cases was sudden, with more or less pain in the right iliac fossa,

[1] See article by author in Journal of the American Medical Association, ...

rant, nausea, vomiting, muscular rigidity, and localized tenderness. There was also fever and a moderate degree of leukocytosis present. The cases were diagnosed as acute appendicitis and the correct diagnosis only made at operation when acutely enlarged, caseous, ileocecal lymph-nodes were found. Microscopic examination of the appendix usually revealed a tuberculous focus, but the finding of the latter is not necessary in order to make the diagnosis, since the bacilli may pass through the intact mucosa into the lymph-nodes of the appendix region.

2. GALLSTONE COLIC.

One of the most frequent acute abdominal conditions to be considered is that which is due to the migration of biliary calculi or of acute cholecystitis as the result of infection of a gallbladder containing calculi. It is a well-recognized fact, however, that attacks of acute cholecystitis may occur without calculi. This is referred to under "Differential Diagnosis."

Diagnosis.—*Pain and Tenderness.*—This is of an excruciating character, exceeding in severity that due to almost every other acute abdominal condition. It is the result of two factors. The first of these is acute cholecystitis resulting from infection. This pain of acute cholecystitis is less severe than the second factor, or pain due to the muscular contractions of the cystic or common duct. This second factor is the chief cause of the pain in biliary colic.

The pain is felt in the right hypochondrium and epigastrium, radiating usually to the right and rarely to the left shoulder. In some cases the pain radiates toward the right iliac region, simulating that of appendicitis.

The entire region between the right costal arch and umbilicus is extremely sensitive to pressure during the attack. If the liver is at a lower level or there is an elongated Riedel lobe, the pain, tenderness, and rigidity may be at the level of the umbilicus or even in the right iliac region itself.

Muscular Rigidity.—This is most marked in the right hypochondrium, but may be at a lower level if the gallbladder is in an abnormal position (see Fig. 187).

Vomiting.—This is an early symptom, consisting at first of mucus, later of bile. It is present almost from the moment of the onset of the pain and recurs frequently during the attack.

Jaundice.—If present at all, it occurs only to a slight degree, in the majority of cases of gallstone colic, due to the passage of a calculus

through the cystic duct. The jaundice is often best seen in the sclera and on the roof of the mouth. When present in marked degree, it signifies the passage or presence of a stone through the common duct.

Fever.—In the majority of cases, there is a rise of temperature in gallstone colic, due to the accompanying cholecystitis. If the temperature and other inflammatory symptoms continue after the pain has subsided, an empyema of the gallbladder is to be suspected. If the gallstone colic is accompanied by repeated chills, followed by a marked rise of temperature and a sweat, there is usually a complicating cholangitis.

The finding of gallstones in the stools is, of course, positive evidence of the attack having been one of biliary colic, but at the present day a diagnosis can be made without such a search.

Differential Diagnosis.—*Acute Cholecystitis.*—Acute inflammation of the gallbladder due to causes other than calculi produces less severe pain than a biliary colic. The abdominal rigidity and tenderness is not so marked, so that the enlarged gallbladder may occasionally be outlined by percussion and palpation. There is, however, *no means of distinguishing absolutely a cholecystitis due to calculi and one due to a simple injection or a catarrhal condition.* In the majority of cases the cholecystitis is the result of calculi.

Renal Colic.—In renal colic, the pain usually begins in the back over the kidney and radiates down the ureter toward the testis and thigh of the same side. The kidney is tender on palpation and the urine contains blood and often pus, but is free from bile.

Appendicitis.—There is no initial rise of temperature, the latter usually appearing after a few hours. The vomiting in biliary colic immediately follows the onset, and not after a few hours, as in appendicitis. The vomiting in biliary colic is also more frequent during the continuance of the pain. The pain in the biliary colic is more severe than in appendicitis, is located higher in the abdomen, as a rule, and radiates to the right shoulder. The muscular rigidity and tenderness are also higher, being most marked just beneath the costal arch. Appendicitis and cholelithiasis at times coexist, so that the clinical picture is a most confusing one.

Dietl's Crises and Floating Kidney.—A floating kidney may cause biliary colic, jaundice, and vomiting, so that a differentiation can only be made if the symptoms cease, when the kidney has been felt and is replaced.

Attacks of severe colic, nausea, and vomiting may occur when the ureter is kinked, through the sudden descent of a movable kidney.

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Gastric and Duodenal Ulcers.—The pain of a gastric or duodenal ulcer is never as severe as that of a biliary colic and it can be more accurately localized in the epigastrium. It begins soon after eating in the case of gastric, and two to six hours later, in that of duodenal ulcer. There is no rigidity or tenderness over the right hypochondrium and no rise of temperature.

3. PERFORATIONS OF ULCERS OF THE STOMACH OR DUODENUM.

The diagnosis of perforations of ulcers in these viscera can be made in the first twelve hours if the previous history is considered in connection with the acute symptoms. In 90 per cent. of perforating gastric and duodenal ulcers there is a history of symptoms referable to an ulcer of the stomach or duodenum, according to Brunner.[1]

Perforating gastric ulcer is more frequent in women (4 to 1), while perforating duodenal ulcer occurs oftener in men (10 to 1). Duodenal ulcer perforates twice as often as gastric ulcer.

The **symptoms** in the majority of cases of perforating ulcer are so typical that a diagnosis can be made from the following symptoms, taken in conjunction with the previous history. This history is usually that given on pages 380 and 387 respectively, viz., of gastric and duodenal ulcers. In some cases there is an absence of any history pointing to previous digestive disturbances.

Pain.—In over 95 per cent. of the cases the pain occurs suddenly and is very severe and stabbing in character, so that the patients cry out, drawing up their limbs, and often become faint. The pain is at first localized by the patient in the epigastrium, but later it becomes more diffuse.

The point of greatest tenderness upon palpation in five-sixths of the cases of gastric ulcer corresponds to the point of spontaneous or subjective pain; while in duodenal ulcer the tenderness is in the right iliac fossa in the majority of cases.

Muscular Rigidity.—This symptom, as in perforations of other viscera, is, when associated with pain, of great diagnostic importance. As elsewhere explained, it can be found by pressing the outstretched hand lightly over the abdomen and not by violently prodding. The abdomen

[1] "Deutsche Zeitschrift f. Chirurgie," Bd. lxix.

is board-like and often retracted until, after six to twelve hours, the tympany, due to beginning peritonitis, causes it to become gradually distended. Muscular rigidity is one of our most valuable symptoms in diagnosis not only of the presence of a perforated viscus, but is also of great aid if localized in pointing toward the particular viscus over which it is located.

Vomiting.—This occurs in about one-third of the cases, and, as in appendicitis, if associated with pain and muscular rigidity is of great diagnostic value. Vomiting which occurs after the first twenty-four hours is usually indicative of a spreading or general peritonitis. Vomiting, as an early sign, follows perforations of duodenal ulcers far more constantly than that of gastric ulcers.

Obliteration of Liver Dullness.—This symptom is so inconstant that but little reliance can be placed upon its presence or absence. Liver dullness is apt to be diminished or absent through tympanites, so that the sign is of little value. If the abdomen is not distended and there is no liver dullness to be found, it is of value taken in conjunction with the localized pain, rigidity, tenderness, and vomiting.

Dullness in the Flanks and Right Iliac Region.—A shifting area of dullness found in the flanks within the first twelve to twenty-four hours is of value as indicating free fluid. Even this symptom is apt to be misleading, and, as in the case of the preceding symptom of obliterated liver dullness too much reliance should not be placed upon it, owing to the fact that paretic intestinal coils filled with fluid feces may give the same signs.

Pulse.—This remains unchanged in many cases until peritonitis begins, when it gradually becomes more rapid and jerky. In some cases it is rapid, feeble, and irregular from the beginning. A gradual but steady rise in the pulse-rate, if the pulse is taken every fifteen minutes, is of great value in confirming the diagnosis of a visceral perforation. This is especially true if the rise in pulse-rate is accompanied by a similar rise in leukocytosis when the count is taken hourly and by increasing localized tenderness and muscular rigidity.

Respiration and Facies.—From the moment of perforation the breathing is often almost entirely costal, shallow and quick, in the effort to avoid movement of the upper abdominal regions. The face and extremities are, in the majority of cases, pale, cold, and clammy; the eyes sunken and the expression of the face one of great anxiety.

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SUBACUTE PERFORATION OF GASTRIC AND DUODENAL ULCERS.

Moynihan[1] and Lund[2] have called attention to the occurrence of perforations of both gastric and duodenal ulcers which pursue a subacute course. In these cases, perforations of chronic ulcers occur, but there is always walling off of the escaping fluids by either the omentum, liver, pancreas, or abdominal wall. The symptoms are less intense than those of an acute perforation. There is sudden pain, followed by vomiting, prostration, but rarely is there any collapse. The abdomen is quite tender and rigid close to the seat of the perforation. The symptoms of localized peritonitis abate slowly. The possible outcome is either resorption, formation of an abscess, or rupture into the general peritoneal cavity.

Differential Diagnosis between Perforation of Gastric and of Duodenal Ulcer.—In deciding whether the perforation is due to a gastric or duodenal ulcer, the following facts must be taken into consideration:

The majority of cases of duodenal perforation occur in men, especially alcoholics; the seat of the initial pain and point of greatest tenderness is to the right of the median line; often the tenderness is most marked in the right iliac region. There is not nearly as frequently a previous history of preceding digestive disturbances as in gastric ulcer. A previous history of tarry stools and the occurrence of vomiting and pain two to six hours after eating, suggest duodenal ulcer.

In perforation of a gastric ulcer, the spontaneous pain and area of greatest tenderness are almost always in the epigastrium. Gastric ulcers occur more often in women about the age of twenty, with a prior history of digestive disturbance, pain soon after eating, and not infrequently of hematemesis. It is almost impossible to accurately locate the exact seat of the gastric perforation.

Differential Diagnosis between these Perforations and Other Acute Abdominal Conditions.—*Appendicitis.*—This is the greatest source of error and is fully considered on page 293. The pain in perforation of a gastric ulcer differs in its seat from that of appendicitis, while that of many cases of duodenal ulcer more nearly coincides with that of appendicitis in being situated in the right iliac region.

In appendicitis the muscular rigidity is in the beginning more localized in the right iliac region and there is seldom a history of digestive disturbances or of pain after eating or hemorrhage from the stomach or bowels.

[1] "Annals of Surgery," vol. xlv, p. 223.

[2] "Boston Medical and Surgical Journal," 1905, p. 516.

Gastralgia.—There are no objective symptoms. The pain is relieved by pressure, has been present on previous occasions, does not last as long and occurs in neurotic persons. There is no history of hematemesis or of melena.

Angina Sclerotica Abdominis.—This relatively rare condition has been mistaken for perforation. In both there is sudden onset of pain, quick pulse, and collapse, but in angina abdominis the pain is higher and passes off more quickly. This form of angina is the result of an arteriosclerosis of the splanchnic vessels and occurs, as a rule, at a later period of life, viz., above sixty than that in which gastric and duodenal ulcers are frequent.

Gallstone Colic.—The pain is less severe and not as sudden, is confined to the gallbladder region, radiates to the right shoulder and there are often chills and rise of temperature. The colic attacks pass away or the pain is intermittent. The gallbladder can often be palpated and there is often a previous history of similar attacks.

The other conditions from which these perforations must be differentiated are discussed elsewhere. They are: Acute pancreatitis; thoracic affections with referred abdominal pain; embolism and thrombosis of the mesenteric artery, etc., lead poisoning, renal colic, torsion of abdominal tumors, perforation of the gallbladder, perforation of a carcinoma of the stomach, and perforation of a tuberculous ulcer of the intestine.

TYPHOID PERFORATION.

Perforation of typhoid ulcers usually occurs in the third week of the disease, but may take place during apparent convalescence. The diagnosis in the majority of cases can be made by careful observation of a sudden change in the patient's condition, accompanied by sharp pain in the right iliac region, muscular rigidity, tenderness, and a gradual but steady rise in pulse-rate, respiration, and in the number of leukocytes (as determined by an hourly count).

In patients who are apathetic all of these symptoms are apt to be overlooked, and the first signs which will call attention to the possibility of a perforation are the change in the expression of the face, rigidity and tenderness over the abdomen, gradually becoming diffuse, accompanied by a rise in pulse-rate and the appearance of marked abdominal distention.

The diagnosis of typhoid perforations in children where collapse, severe abdominal pain, uncontrollable vomiting, tenderness, and distention are all much less marked is far more difficult than in adults.

Another condition which may prevent making an early diagnosis in typhoid perforation is to be found in the distention of the abdomen which is so often present in the more severe cases of typhoid fever.

If a diagnosis of perforation has not been made from the characteristic pain, muscular rigidity and tenderness of the right iliac region, accompanied by an increased pulse-rate, fall of temperature and collapse, then such a diagnosis must be made from the symptoms of beginning peritonitis. These are: abdominal tenderness and rigidity, at first localized but become more widespread from hour to hour, repeated vomiting gradually increasing abdominal distention, if the latter has not existed before the onset of the pain and a steady increase in the pulse-rate. The loss of liver dullness is so inconstant a symptom as to be of little value in making a diagnosis of perforation. In many cases the blood-count may be of aid, frequently the normal leukopenia of typhoid being replaced by a gradually increasing leukocytosis.

Differential Diagnosis.—*Hemorrhage.*—The symptoms of hemorrhage from a typhoid ulcer of the ileum may simulate those of perforation or the two may coexist. Both produce symptoms of collapse, such as sweats, rapid pulse and respiration, sunken eyes, etc. But hemorrhage is not attended by such marked pain, tenderness, or rigidity in the right iliac region, and in an hour or two blood is passed with the bowel movement. If there is no reaction from the collapse symptoms, and abdominal tenderness, rigidity, and distention begin to appear, the case should be looked upon as one of perforation, either accompanied by or independent of hemorrhage.

Appendicitis.—Vomiting is more apt to accompany the initial pain in appendicitis, and there is not apt to be such an amount of collapse in the early hours of an attack as is the case in intestinal perforation. Appendicitis due to the typhoid bacillus or an appendicitis accidentally manifesting during an attack of typhoid fever will, as a rule, appear much earlier in the course of typhoid than a typhoid perforation.

Cholecystitis.—This usually occurs at a somewhat earlier period in the course of typhoid than does a perforation, and is accompanied by less severe pain, muscular rigidity, and tenderness just below the costal arch, and not over the right iliac region. There is also at times a mass to be palpated or dullness to be elicited at an early stage.

Suppurating Mesenteric Glands.—Every case described during the past few years, of suppuration and rupture of the mesenteric glands occurring during typhoid and simulating perforation, has had symptoms of pain, collapse, rapid pulse, etc. The muscular rigidity, however, is not so well localized, as a rule in the right iliac region, nor are

general abdominal tenderness and distention so likely to follow, as in genuine typhoid perforation.

Acute Dilatation of the Stomach.—Several cases have been reported in which the symptoms of a sudden, acute dilatation of the stomach occurring during the latter weeks of typhoid fever simulated a perforation of the intestine. The differentiation can be made by the characteristic vomiting, etc. (see page 379), of the stomach condition.

4. ACUTE PANCREATITIS.

The occurrence of sudden severe pain in the epigastrium, accompanied by faintness or collapse and by vomiting, should lead one to suspect an acute pancreatitis, if the other acute conditions which occur in the upper abdominal region can be excluded.

In addition to the above triad of symptoms, there is muscular rigidity and tenderness over the epigastrium, and a tender mass can be felt here. If suppuration occurs a rise of temperature persists after the subsidence of the acute symptoms, and with it a leukocytosis. In many cases death occurs on the second to the fourth day of the disease. In the acute cases there is marked constipation, but this is not so absolute but that flatus can be passed by the aid of an enema. This serves to differentiate it from an intestinal obstruction. There is also fat in large quantities in the stools. The pain may be so severe as to produce syncope or collapse, and it has a tendency to become paroxysmal (Robson and Cammidge). The pain is soon followed by distention in the upper abdominal region, which later becomes general. There is usually slight jaundice present, but this may be quite intense, if the ampulla of Vater is completely blocked by a calculus. The preceding description applies to either the acute hemorrhagic, gangrenous, or suppurative varieties.

Subacute Pancreatitis.—There is a *subacute form* in which the symptoms are all less violent. There is a constant dull epigastric pain, loss of flesh, and the vomiting is less severe. There is diarrhea instead of constipation, pus and blood appearing in the fetid stools. If an abscess has developed there is a very tender epigastric tumor accompanied by chills and fever. In these cases of subacute pancreatitis there is usually a history of preceding recurrent attacks of biliary colic with or without jaundice and chills and fever.

Differential Diagnosis.—At first the differential diagnosis must be made from intestinal obstruction, perforating duodenal or gastric ulcer, ruptured gallbladder or bile-ducts, phlegmonous cholecystitis, and gangrenous appendicitis. The swelling will usually be less general in pan-

creatitis than in obstruction, and, even if the bowels will not move, flatus can generally be passed. In perforation of a duodenal or gastric ulcer there will generally have been premonitory symptoms pointing to the disease before the perforation actually occurs, and almost immediately an absence of liver dullness may be found. In acute ptomain poisoning the history, the more general character of the pain, and the presence of diarrhea will usually help the diagnosis.

In phlegmonous cholecystitis the symptoms are usually preceded by a swelling and well-marked tenderness beneath the right costal margin, at first distinctly localized, and only later extending to the epigastrium and umbilical region, where the tenderness is generally found in acute pancreatitis from the beginning of the illness; moreover, the history of gallstones will usually be elicited. In appendicitis the tenderness below, and to the right of, the umbilicus, and the swelling in that region usually remove the difficulty created by the pain in both appendicitis and pancreatitis, being frequently felt at first just above the umbilicus. In acute pancreatitis the excruciating pain, at first epigastric, but later general, the extremely rapid loss of weight, and the irregular tenderness opposite to, and above, the umbilicus are usually characteristic. The urinary test for the "pancreatic crystals" should not be neglected, as a positive reaction has been obtained in all the cases of acute pancreatitis in which Robson and Cammidge have had the opportunity of employing it.

5. RENAL COLIC.[1]

Symptoms.—In a typical case, the pain is intense, causes faintness and collapse symptoms, such as feeble, rapid pulse, cold, clammy skin and extremities. The pain is paroxysmal and begins usually in the back over the kidney, radiating along the ureter to the testis or labia and thigh.

At the onset, in addition to the pain and collapse, there is often a chill and vomiting. The attack may last three to five days and then suddenly subside.

The urine during the attacks contains blood, which can at times only be found by the aid of the microscope. Frequency of micturition accompanies the attacks. The passage of the calculus during or shortly after the attack is confirmatory evidence. Should the calculus slip back, or should the attack be due to a twisted ureter, an unusual amount of urine often follows the subsidence of the pain.

[1] Renal colic, as shown on page 420, is only a symptom, and may be due to a number of different causes. Its chief characteristic symptoms as an acute abdominal condition will be briefly described here, but the subject is more fully discussed in the pages devoted to surgery of the kidney (see page 416).

The diagnosis of atypical cases of renal colic and the diagnosis of renal calculus in general are discussed on page 420.

6. DIETL'S CRISES.

These are attacks of acute abdominal pain, first described by von Dietl of Vienna, accompanied by nausea, chills and vomiting. These are due to the kinking or bending upon itself of the ureter in movable kidney (Fig. 213). The pain may be quite severe and usually radiates along the ureter, as in renal colic, due to calculus and other conditions (see page 312). During the attack the kidney is swollen and tender, this condition lasting several hours. In some cases a distinct hydronephrosis develops during the attacks. Blood is present in the urine only after the attack has subsided, and is accompanied by the sudden voiding of a large quantity of urine, while during the attack there is diminished secretion of urine (oliguria).

FIG. 213.—LATERAL VIEW OF RELATIONS IN INTERMITTENT HYDRONEPHROSIS OCCURRING IN A FLOATING KIDNEY DUE TO KINKING OF THE URETER.

H, Enlarged kidney. Note the kinking of the ureter.

The diagnosis may be made from the palpation of the swollen, tender, displaced kidney, and the fact that when it is replaced the symptoms cease.

There is but little abdominal rigidity, no fever or leukocytosis, and the condition occurs most frequently in multiparous women who suffer from a visceroptosis.

Differential Diagnosis.—*Renal Colic Due to Calculi.*—In renal colic due to calculi, the symptoms of pain radiating along the ureter,

of nausea and of vomiting, etc., are the same as in Dietl's crises. The pain, however, is much more severe in ureteral colic due to the passage of calculi and is usually accompanied by symptoms of collapse, such as cold, clammy sweat, rapid pulse, etc. There is also blood in the urine during the attacks, while in kinking of the ureter it is only present at the end of the attacks.

If, however, the attacks of kinking of the ureter follow in rapid succession, blood is found in the urine all of the time and a differentiation is very difficult without the use of the *x*-ray (see page 425). Renal colic due to calculi is less apt to be accompanied by enlargement of the kidney.

Gallstones.—The pain is located higher up in the abdomen, is much

FIG. 214.—PROMINENCE OF ABDOMEN AS RESULT OF TYMPANITES FOLLOWING THROMBOSIS OF THE SUPERIOR MESENTERIC ARTERY IN A WOMAN WITH A PENDULOUS ABDOMEN.

more severe, and there is rigidity and tenderness over the region of the gallbladder. The pains also radiate to the shoulder. If the patient is placed upon the left side, the movable kidney can be more distinctly palpated.

7. EMBOLISM AND THROMBOSIS OF THE MESENTERIC VESSELS.

An acute abdominal condition which is far more frequent than was formerly thought follows the occlusion of the mesenteric vessels (Fig. 215).

Clinically it is impossible to distinguish embolism of the superior or inferior mesenteric artery from thrombosis of the mesenteric veins.

Both conditions produce, as a rule, very acute symptoms. In some

cases they resemble those of intestinal obstruction; in another class of cases the symptoms are those of general peritonitis.

Embolism occurs in both sexes after middle life, secondary to endoarteritis or atheroma of the mesenteric vessels. Thrombosis may be primary, following acute infective processes, especially of the appendix. It may occur secondary to any hepatic condition which causes portal stasis.

In but few cases has it been possible to make a diagnosis before operation, nor is this absolutely necessary, since the symptoms are so acute that an exploratory laparotomy is indicated, even if only a probable diagnosis has been made. Upon opening the abdomen one finds all of the presenting coils of intestine in the various stages of gangrene, from a dark red gut just losing its luster to the completely gangrenous one. There is usually a more or less free turbid fluid in the peritoneal cavity.

The disease begins in one of two ways. (*a*) Symptoms which simulate intestinal obstruction, with or without peritonitis. This form begins with colicky abdominal pain followed by nausea or vomiting and absolute constipation, so that not even flatus is passed. The abdomen soon becomes so distended, rigid and tender that palpation becomes very difficult (Fig. 214). (*b*) Symptoms of hemorrhage from the intestine. In this form the symptoms of early bowel paralysis are not so marked, but there is great prostration, severe colicky pain, and frequent bloody stools.

Differential Diagnosis.—This is impossible in the majority of cases, except by exclusion and by bearing in mind the fact that embolism occurs after middle life. It must be differentiated from perforations of gastric and duodenal ulcers, from acute cholecystitis (page 268), appendicitis (page 293), etc., and the various forms of intestinal obstruction, as well as the condition described on page 318 as angina sclerotica abdominis.

8. TORSION OF THE PEDICLES OF OVARIAN AND UTERINE TUMORS.

The presence of such a tumor may reveal itself for the first time when the pedicle has become twisted. The onset is sudden, with severe colicky pain referred to the pelvis, accompanied by vomiting and slight muscular rigidity. If the tumor becomes gangrenous, these primary symptoms are rapidly followed by those of a spreading peritonitis. The rigidity and tenderness, which were at first present in only the lower part of the abdomen, become general. The pulse-rate increases rapidly and abdominal distention becomes marked, and the patient septic.

The diagnosis may be made by a pelvic examination and the palpation of the tumor mass and its pedicle. Without the use of an anesthetic, such examination can only be made with difficulty, owing to the muscular rigidity. In some cases a history of gradual enlargement of the abdomen, preceding the acute attack, can be obtained.

After a septic paralysis of the bowels has occurred, the case cannot be differentiated from peritonitis due to other causes, unless the vaginal examination shows the presence of a tumor and its pedicle.

Differential Diagnosis.—*Appendicitis.*—In the early hours, if the tumor is located on the right side, there may be some resemblance. The palpation of a tumor will, however, at once exclude an appendicitis, since such a large inflammatory mass does not form in so short a time. Later on such a mass may resemble appendicitis with abscess formation, but the tumor is more elastic and there is more general abdominal rigidity and tenderness, as well as other symptoms of a spreading peritonitis.

9. TORSION OF THE SPERMATIC CORD.

This may occur in an imperfectly or in a normally descended testis (Fig. 279). It usually follows heavy lifting, etc. The onset is very sudden, greatly resembling that of a strangulated hernia. The attack begins with severe pain in the region of the testis, far greater than in an ordinary epididymitis, accompanied by collapse, vomiting, constipation, great local tenderness, and swelling. The principal condition from which it must be differentiated is a strangulated hernia. This is as follows (Eccles):

	Torsion of Cord.	Strangulated Hernia.
History	Probable of strain.	Often of strain.
Position of testis	Often imperfectly descended.	Usually fully descended.
Shock	Moderate.	Often severe.
Vomiting	Slight and not persistent.	Severe and persistent.
Constipation	May be present.	Is absolute.
Tenseness of swelling	Not marked.	Marked.
Impulse on coughing	None.	None.
Condition of cord	Tender, twisted, and swollen.	Not to be felt.

10. VISCERAL CRISES.

These may occur either as a complication of tabes or of an angioneurotic edema.

Those due to tabes may at times be so severe as to fully simulate some of the previously named acute conditions, such as appendicitis, perforation of ulcers, gallstone colic, or even intestinal obstruction.

In patients at or above middle age, especially males, who have such symptoms, the possibility of visceral crises of tabes must not be overlooked, and other evidences of the disease searched for.

In the most typical cases there are severe epigastric pains, repeated vomiting, great prostration, and rapid pulse. The attack may ter-

FIG. 215.—GANGRENE OF A SINGLE LOOP OF SMALL INTESTINE DUE TO EMBOLISM OF MESENTERIC ARTERY (Kemerson).

minate fatally in a short time, or continue for several hours or even for days and recur from time to time.

Crises are also associated with various manifestations of skin affections of the erythema group, and with attacks of angioneurotic edema. There is severe abdominal pain which may last for hours.

One case, described by Osler,[1] was mistaken for renal colic. The pain is sometimes accompanied by nausea and vomiting, in other cases by diarrhea, and in still others by the passage of blood.

The diagnosis can only be made from the history of the cutaneous affections or of repeated attacks of sudden edematous swelling in various parts of the body.

11. ANGINA SCLEROTICA ABDOMINIS (ORTNER'S DISEASE).

This occurs in elderly people in the form of attacks of severe pain in the epigastrium. It is due to an atheromatous condition of the vessels of the splanchnic area and must be differentiated from lead colic and from the crisis of tabes. The attacks may be accompanied by diarrhea. The stool at times contains large quantities of blood.

12. REFERRED PAIN FROM SPINAL AND THORACIC CONDITIONS.

Spondylitis, and tumors of the spinal cord, of its membranes, or of the vertebræ, may cause severe abdominal pain, which is referred to the terminal filaments of the spinal nerves of the corresponding segment in the abdominal wall. The pain is seldom as acute as in true abdominal affections, and is not accompanied by muscular rigidity or tenderness. Examination of the spine for evidences of spondylitis (page 684) will soon reveal the nature of the referred pain. Examination of the nervous system and the history of the case will eliminate tumors of the cord or spinal column.

Thoracic Conditions.—Cases of both pneumonia and pleurisy occur, in which there is complaint of severe pain in the abdomen at the onset of the disease. This is especially true in children. There may be rigidity of the abdominal muscles on the side affected. In pneumonia there is a history of a chill. The acute onset is followed by dyspnea, and marked increase in respirations and pulse-rate. The pain is seldom as well localized as in the acute abdominal conditions, nor is the muscular rigidity as circumscribed and constant.

There is one form of pleurisy (diaphragmatic) which simulates acute abdominal affections very closely. The breathing is shallow and costal, the pain is severe and referred to the upper abdominal region, as in perforations of gastric and duodenal ulcer, acute pancreatitis, etc.

Objectively but little can be found and a differential diagnosis is difficult in the early hours. The case should be watched for several hours before a final diagnosis is made.

[1] "American Jour. Med. Sciences," Jan. 1, 1904.

13. INFLAMMATION OF THE INTRAABDOMINAL PORTION OF THE VAS DEFERENS.

Severe pain, of a colicky nature, referred either to the right or left iliac regions is the initial symptom. It is later accompanied by nausea or vomiting, as a forerunner of epididymitis or orchitis.

When this condition exists on the right side, it may be mistaken for an appendicitis. Especially when it precedes the orchitis of mumps, one must avoid this error.

In gonorrheal cases, the diagnosis may be made from the urethral discharge, which often ceases suddenly before such an attack. When it follows mumps, the previous history is of value.

The most tender point is not over the middle of the right iliac region (McBurney's point), as in appendicitis, but is deeply situated over the middle of Poupart's ligament or deep down in the pelvis. Rectal examination is of great aid in making a differentiation.

GROUP III.—EARLY SIGNS OF INTESTINAL OBSTRUCTION.

ACUTE INTESTINAL OBSTRUCTION (ILEUS).

In every case before a definite diagnosis of intestinal obstruction is made three points must be considered:

1. What symptoms indicate intestinal obstruction?
2. What is the probable nature and seat of the obstruction?
3. What other symptoms might simulate it?

1. **Symptoms of Intestinal Obstruction.**—The most typical ones are:

(*a*) Absolute constipation.

(*b*) Constantly recurring vomiting finally becoming fecal.

(*c*) Pain of varying intensity and location.

(*d*) Gradual or sudden distention of the abdomen.

(*e*) Gradually increasing pulse-rate.

(*f*) Visible peristalsis and the presence of a tumor.

(*g*) Collapse symptoms, such as sunken eyes, anxious face, cyanosis, pallor, dyspnea.

If a patient, suffering from a sudden attack of abdominal pain, has constantly recurring vomiting, and every effort to secure the passage of feces or flatus results negatively, a diagnosis of intestinal obstruction may be made.

The three symptoms common to all forms of abdominal obstruction are:

1. Absolute inability to secure the passage of feces or flatus.
2. Vomiting first of mucus, then of bile, and lastly of fecal matter.
3. Pain.

Constipation is often the first symptom. Before declaring it absolute, however, high rectal enemata should be given, with the patient lying on his back with hips elevated. The fountain syringe or irrigator does not need to be raised more than three feet above the patient. An ordinary high rectal tube is inserted almost its full length, the fluid being allowed to run through the tube during its insertion into the rectum. The temperature of the liquid should never be above 110° F. and the quantity used should not exceed two quarts in adults and one and one-half pints in children. To test the passage of flatus most accurately it is best to keep the outer end of the tube under water and thus observe the escape of bubbles of gas as they leave the tube.

If no morphin has been given, and all the fecal matter below the obstruction has been washed out, and there is no escape of flatus or feces on repeating the enema, the conclusion can be drawn that some obstruction either of adynamic or mechanical nature exists.

The only exception to the statement that absolute constipation is one of the most important diagnostic signs of intestinal obstruction occurs in those cases of intussusception in which sufficient lumen remains in the center of the invaginated gut to permit the passage of frequent liquid fecal stools. The diagnosis in such cases must be made from the other special signs of intussusception, referred to below.

Vomiting.—The most characteristic emesis is that occurring either with or independently of pain, but so frequently repeated that nothing is retained.

Fecal vomiting does not usually appear until the third or fourth day. Therefore a diagnosis must be made at an earlier period to be of value in saving the patient's life by operation.

The vomiting which accompanies the pain of other acute abdominal affections, such as appendicitis, is primary, *i. e.*, it occurs perhaps once or twice within the first few hours after the onset of pain, but is not frequently repeated unless peritonitis sets in.

In intestinal obstruction the emesis begins rather innocently at first, as in the affections of Group II, but constantly recurs, so that anything which is swallowed remains in the stomach but a short time.

The vomitus is at first composed of the food ingested before the attack began, mixed with mucus. Later it consists of the bilious vomit, so frequently seen in acute gastroenteritis, though more frequently repeated than in the latter. After a variable time, usually the third to fourth day, it becomes of a brownish-black color and of fecal odor. Emesis is then almost constant.

Pain as a diagnostic sign varies greatly. It is most marked in obstruction due to volvulus, to bands, or to protrusion through external or internal hernial apertures.

There are cases in which but little pain is present and the diagnosis must be made from the absolute constipation, constant vomiting, and gradually increasing tympanites.

The pain is at first sharp and colicky in character. Later it becomes more or less continuous, until, the paralysis having become complete on the third or fourth day, pain ceases.

A gradually increasing distention of the abdomen is characteristic of intestinal obstruction. Its distribution over the abdomen varies according to the seat of the obstruction, and is referred to in detail later. The pulse-rate does not, as a rule, increase as steadily as in peritonitis. In some forms of obstruction, however, such as intussusception, the pulse-rate is rapid and weak from the beginning.

Peristaltic waves may, at times, be seen traveling in an opposite direction from the normal during the first forty-eight to seventy-two hours. This is to be seen quite easily before the abdominal distention is too great, provided there is not too much fat in the abdominal wall.

A tumor is palpable in many cases in which the acute symptoms follow those of chronic stenosis of the bowel, of long duration. It can also be felt in cases of intussusception along the transverse colon, in the left iliac fossa, or per rectum.

The symptoms of collapse appear gradually in the majority of cases, usually about the third or fourth day. Rarely, they appear suddenly, at an earlier period, in cases of volvulus.

Probable Nature and Seat of the Obstruction.—Every patient should be examined before operation to ascertain these facts. Such examination should include:

(*a*) The previous history.

(*b*) The physical examination of the abdomen itself.

(*c*) Rectal and vaginal examination.

STRANGULATION.

History.—Strangulation most frequently occurs in adults who have a previous history of attacks of abdominal pain, a previous attack of peritonitis, an operation on the abdominal viscera, or a recognized hernia. The previous history may, however, throw absolutely no light on the present condition, especially in those cases in which strangulation by bands derived from Meckel's diverticulum occurs. The previous existence of a hernia is of value, since strangulation of only a portion

or the whole of a coil of intestine (acute partial enterocele) may give rise to the same symptoms as though the entire lumen of the gut were obstructed.

Abdominal Pain.—This is usually quite severe and of a colicky nature. In the case of strangulated hernia it is most marked in close proximity to the hernial opening.

Nausea and Vomiting.—These occur quite early and are more marked in this form of intestinal obstruction than in any other except volvulus. Vomiting becomes fecal from the third to the fifth day.

Constipation.—This is absolute in strangulation. Enemata given in the early hours bring away some fecal matter; after this they result negatively.

Shock.—This is quite marked, as a rule, although it may not appear until the second or third day of the obstruction.

Examination of Abdomen.—The distention of the abdomen appears quite early, being especially marked in the central portions of the abdomen if the small intestine is involved, and in the lateral portions if the large intestine is obstructed. Peristalsis may be seen in the early hours, through a thin abdominal wall. It can often be artificially elicited by light tapping on the abdominal wall.

Volvulus.

This can rarely be diagnosed before operation.

Previous History.—It occurs most often in adults, especially those suffering from chronic constipation. At times there is a history of previous attacks of peritonitis.

Pain.—Pain is often severe from the beginning, and in some cases quite accurately localized to the left of the umbilicus. It is very severe and colicky in nature.

Nausea and Vomiting.—These do not occur as early as in strangulation and the vomitus becomes fecal on the third or fourth day.

Constipation.—This is more marked at an early period than in any of the other forms of obstruction, owing to the fact that the large intestine is involved.

Shock.—This does not occur as early as in strangulation or intussusception, but may come on quite suddenly on the third or fourth day, and be extreme in character.

Examination of Abdomen.—Visible peristalsis may, at times, be seen on the left side of the abdomen, beginning at the point of obstruction and traveling upward and downward along the line of the transverse

colon. The distention of the abdomen is much more extensive than in obstruction of the small intestine by strangulation. It is especially marked along the lateral aspects of the abdomen, often being horseshoe in outline, corresponding to the course of the colon.

FIG. 216.—INTUSSUSCEPTION.

The illustration was made from a specimen of intussusception in an adult, in which the clinical picture was that of an appendicitis. It is of the iliac variety, in which one portion of the ileum has been invaginated into the other, the latter representing that portion of the ileum which is in close proximity to the ileocecal valve The difference in color of the invaginated mucous membrane, which was deeply congested and hemorrhagic, s well shown. (Case of Dr. L. A. Greensfelder.)

INTUSSUSCEPTION.

The following are the most characteristic diagnostic points of intussusception, according to Hess, who has collected them from 1028 cases.

Previous History.—There may be a history of some intestinal disturbances, rarely one of abdominal trauma, but in the majority of cases the first symptoms appear very suddenly.

Abdominal Pain.—First symptom without premonition, colicky in character, uninterrupted at onset, later intermittent. In children inability to localize it.

Nausea and Vomiting.—Nausea and vomiting occur either simultaneously with the pain or immediately after. May be continuous or occur at intervals.

Evacuations of the Bowels.—In acute cases we usually have one or more evacuations of fecal matter. After this, if occlusion is complete, there is complete absence of the passage of fecal matter and flatus. Hemorrhagic evacuation is one of the most constant symptoms of invagination. It varies from a few streaks to a profuse hemorrhage, which may cause death.

Prostration.—Prostration is sudden in development and out of proportion to the other symptoms present.

Tumor.—This is the most important physical sign from the diagnostic standpoint. In 197 cases in which there is a complete history, 183 gave the history of the presence of an abdominal tumor. The presence of a rectal tumor was noted in 35 cases and an absence of same in 38 cases. The most frequent seat of the tumor is the region of the sigmoid flexure. The tumor is relatively very movable.

Meteorism.—Meteorism is usually slow in development and its absence is of diagnostic import. It depends upon the degree and seat of the obstruction. In intussusception occurring in the ileum, it is always more marked than is the case lower down.

Tenesmus.—Tenesmus is much more frequently present than is meteorism. It is especially severe in intussusception of the sigmoid and rectum.

Condition of the Abdomen.—Characteristic symptoms or signs, recognizable on the abdomen superficially, are usually absent.

Fever.—Fever occurs in about 40 per cent. of all cases of invagination in which the symptom is mentioned. Its presence is to be expected when complications have taken place.

Obstruction from Tumors or Foreign Bodies.

History.—An obstruction from gallstones is to be suspected in elderly women, especially if there has been a history of prior attacks of gallstone colic. Obstruction from tumors can only be suspected

if there is a previous history of gradual loss in weight, or if symptoms of chronic stenosis, like those referred to on page 395, have been present for some time before the symptoms of complete obstruction occurred. The symptoms of obstruction from tumors or foreign bodies appear rather insidiously in adults, as compared with those due to strangulation or volvulus. There is but little pain and abdominal distention is much more gradual in its onset.

Pain and vomiting are not marked or severe, as a rule. The peristalsis is very distinctly visible through the thin abdominal wall in this form of obstruction. The constipation is absolute, however.

Rectal and vaginal examinations are of the greatest value in adults in this form of obstruction for the purpose of determining the presence or absence of impacted feces or the presence of a pelvic tumor which causes compression of the intestine. In this form of obstruction there may be apparent relief, consisting in the passage of feces and flatus, and then recurrence in the form of symptoms of absolute obstruction.

Adynamic Ileus.

A form of intestinal obstruction due to acute paralysis of the muscular fibers of the intestinal coats is called adynamic ileus. It may follow laparotomies, injuries of the spinal cord in the dorsal region (see page 762), or may appear without any apparent cause. It is not due to a septic paresis of the intestine, but the result of inhibition of nerve impulses. The diagnosis differs only in the history and absence of objective findings from the other forms of obstruction.

Differential Diagnosis of Acute Intestinal Obstruction.

The principal conditions from which acute intestinal obstruction must be differentiated are the various affections mentioned under Group II. It is often very difficult to differentiate acute ileus from a spreading or general peritonitis, especially on the second or third day, after the occurrence of bowel paralysis in the latter condition. This difficulty is due to the fact that at this period there is in both, absolute constipation, incessant vomiting, great prostration, and rapid pulse. There is, perhaps, less rigidity and less pain in these advanced cases of intestinal obstruction than in those of peritonitis. Of great diagnostic import is the presence of a history pointing to an appendicitis or some similar condition, and of like importance is the finding of a strangulated hernia, or other causes of intestinal obstruction. In the early period, *i. e.*, in the first

twenty-four to thirty-six hours, the following differential points are of value:

	Acute Peritonitis.	Acute Intestinal Obstruction.
1. Rigidity	Uniform and marked.	Not so marked.
2. Abdominal distention.	Gradual.	Rapid except in intussusception.
3. Visible peristalsis	Not present.	Often visible in early hours.
4. Pulse	Gradual increase in frequency.	Rapid increase in frequency.
5. Vomiting	Present at first but does not recur until third day.	Incessant from beginning, becoming fecal.
6. Constipation	Some results from enemata in early hours.	No result except in fecal impaction.

Other conditions from which intestinal obstruction must be differentiated are:

Acute Pancreatitis.—In this the constipation is not complete. Vomiting never becomes fecal. The rigidity is confined to the upper half of the abdomen and the shock and severe pain in the epigastrium are present from the onset.

Acute Enteritis.—In this there may be repeated vomiting and pain at the umbilicus; there is usually diarrhea present or it is possible to secure bowel movements by means of enemata. The pulse does not increase in frequency as the hours pass, except when the diarrhea is very copious. Abdominal rigidity is, as a rule, not present.

Perforation of an Ulcer of the Stomach or Intestine.—As in pancreatitis, the symptoms of shock and pain are more severe and sudden from the beginning. There is often a previous history of ulcer and the symptoms of peritonitis gradually develop.

Thrombosis and Embolism of Mesenteric Artery.—The symptoms of this condition, when there is no blood passed with the bowel movement, resemble greatly those of acute obstruction, and it is impossible to make a diagnosis before operation, but the possibility of embolism occurring in a person suffering from arteriosclerosis must be borne in mind. Aside from this, the history will throw but little light on the diagnosis.

The symptoms of paralysis of the gut in this condition are so rapid in their onset that it is impossible, in the majority of cases, to distinguish between this condition and obstruction from mechanical or dynamic causes.

Finally, it may be said that the *diagnosis of intestinal obstruction often cannot be made at the first examination in the early hours. But the examination should be repeated from hour to hour*, and if no bowel movement has occurred or the enemata are unsuccessful, and the vomiting continues, accompanied by rise of pulse-rate and abdom-

inal distention, no delay should be permitted in performing an exploratory laparotomy. Such an operation, delayed more than forty-eight hours, during which the patient is becoming toxic from the absorption of stercoraceous material and suffering from the shock of intestinal obstruction, usually proves fatal.

Group IV.—Early Signs of Internal Hemorrhage.

RUPTURED EXTRAUTERINE PREGNANCY.

There is often a history of a long period of sterility, or a history of pelvic disease followed by a partial or entire cessation of menses for one or more periods, and the signs of pregnancy with expulsion of decidua per vaginam from time to time. Continuous pain during the pregnancy and progressive anemia are also valuable signs. The same is true of the presence of the signs of pregnancy in an irregular or atypical manner.

The rupture of such a pregnancy may be diagnosed from the sudden onset of severe abdominal pain, accompanied by collapse, in a woman having the above history.

The face and visible mucous membranes are very pale, there is great restlessness and thirst, repeated attacks of syncope, and a rapid, weak pulse. The abdomen is uniformly rigid and tender, but not as marked as in a peritoneal infection. Distention gradually increases and may become quite marked. Bimanual examination may reveal a tender mass lateral to the uterus or in the culdesac of Douglas.

ABDOMINAL TUMORS.

When we examine a patient with an abdominal tumor two questions present themselves:

1. Which viscus is involved?
2. What is the nature of the tumor?

These two questions cannot be answered without careful consideration of all of the data at hand.

These data are acquired as follows:

1. A detailed history is taken.
2. The great probability of tumors of certain viscera occurring in the corresponding locations.
3. The results obtained from an examination of the abdomen augmented by certain tests and procedures to be described.

1. **History.**—In considering the history one must not fail to note the age, habits, venereal history, prior illnesses, previous operations,

gain or loss in weight, rapidity of enlargement of the abdomen, and any other symptoms accompanying the presence of the tumor. These are referred to again in connection with the individual forms of tumors.

2. **Probabilities of Tumors of Certain Viscera Occurring in Corresponding Locations.**—The normal location and other characteristics of each abdominal viscus must be borne in mind. This is of considerable aid in making a diagnosis, since in the case of any tumor we must first think whether it corresponds in location to some normal viscus. We can often identify certain tumors by their resemblance in outline, edge and consistency to such a normal viscus. This is especially true at an early period of the development of the tumor.

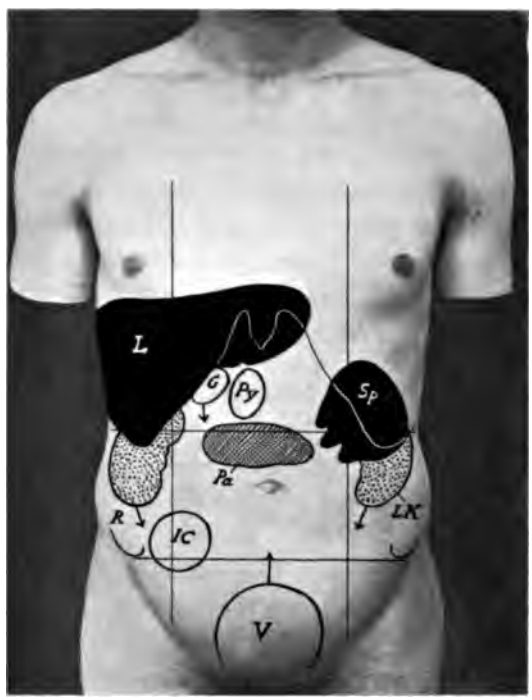


FIG. 217.—MOST FREQUENT LOCATIONS OF VARIOUS TUMORS OF THE ABDOMINAL VISCERA.

The black arrows indicate the directions in which they grow: *L*, Liver; *G*, gallbladder; *Py*, pylorus; *Pa*, pancreas; *R*, right kidney; *LK*, left kidney; *Sp*, spleen; *IC*, ileocecal tumors; *V*, tumors due to distended bladder, ovarian cysts growing upward, fibroids of uterus, etc.

Many tumors of the gallbladder, liver, spleen, and kidney, correspond in both their position and shape to the normal organ (Fig. 217).

An overdistended urinary bladder may be mistaken for an abdominal tumor unless the normal location and shape, when it is full, are remembered.

It is not to be denied that certain organs, if situated in a part far away from their normal location, may be normal in size or be markedly altered and not be recognized as belonging to these viscera. Thus a normal-sized spleen may be displaced so as to lie in the right iliac fossa, or a kidney be located in the pelvis.

These are exceptional cases, and yet it is these very unusual forms

which render the diagnosis of abdominal tumors a difficult problem which in many cases only an exploratory laparotomy solves.

3. **The Results Obtained from the Abdominal Examination and its Adjuncts.**—This should be undertaken in a systematic manner by the usual methods of physical diagnosis, especially inspection, palpation, and percussion. The necessity of rectal, vesical, and vaginal examination should never be forgotten. In addition, it is necessary to have a good working knowledge of all that chemical and microscopic

FIG. 218.—METHOD OF PALPATING THE GALLBLADDER OR PYLORUS.

The patient should be laid upon the back with the shoulders slightly raised and thighs flexed upon the abdomen, so that the soles of the feet rest squarely upon the bed. The examiner should approach the patient from the right, laying the hand flat upon the abdomen, and insert it gradually deeper while the patient is instructed to breathe, and thus relax the abdominal wall.

analysis will reveal. Lastly, inflation of the stomach and colon will throw much light on the diagnosis.

Under certain conditions examination of the abdominal cavity is rendered very difficult. These conditions are:

1. Rigidity of the abdominal wall. This is especially the case in infants and young children, in nulliparæ, in muscular male adults, or where inflammatory changes are present. It may be necessary to give an anesthetic to overcome this resistance.

2. A great amount of fat in the abdominal wall. This is one of

the greatest obstacles, and is not always overcome, even though the abdomen be relaxed or an anesthetic be given.

3. The presence of free fluid in the peritoneal cavity.

In such cases it is often necessary to tap the abdomen and examine the patient before the fluid has had an opportunity to reaccumulate.

4. The presence of a considerable degree of tympanites.

5. The presence of a distended bladder.

In general, the best posture for examination is with the patient lying upon the back, with the shoulders raised and thighs flexed upon the abdomen. Certain special postures and methods are described with the form of tumor in which they are of use.

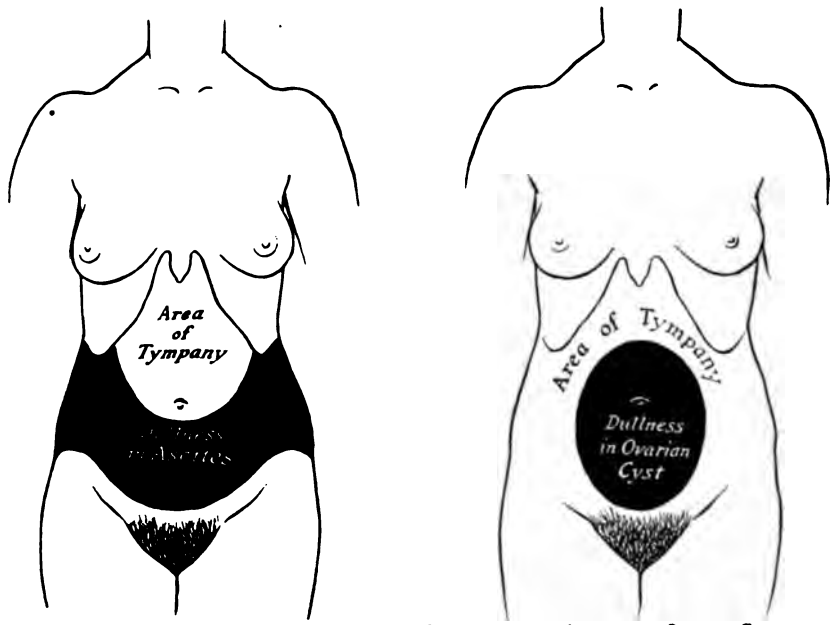


FIG. 219.—AREAS OF DULLNESS AND TYMPANY RESPECTIVELY IN ASCITES AND OVARIAN CYST.

I. *Inspection.*—This shows us the following:

(*a*) The dilatation of the superficial veins. This may indicate obstruction in the portal circulation if central, and in the vena cava inferior if lateral (Fig. 228). Pelvic tumors also cause visible, dilated veins.

(*b*) The color of the skin. A change involving the color of the entire body, for example, jaundice in carcinoma of the pancreas (Fig. 226) or anemia in malignant conditions, may occur.

(*c*) Where the enlargement, if visible, is located, *i. e.*, ascites causes a general widening, while ovarian cysts enlarge the lower portion of the abdomen. Tumors of the spleen or kidneys enlarge their corresponding

lateral regions. A dilated stomach or a pancreatic cyst causes a prominence around the umbilicus.

II. *Palpation.*—The warm hands should be laid flat upon the abdomen (Fig. 202), deeper pressure being made gradually. For renal tumors bimanual palpation is necessary (Fig. 185). Ballottement is useful for deep tumors.

Palpation reveals:

(*a*) The respiratory mobility of the tumor. Tumors of the stomach, liver, and gallbladder and kidneys move up and down with respiration unless they are fixed by adhesions. Tumors of the ovary and uterus do not move with respiration.

(*b*) The passive mobility of the tumor. Tumors of the large intestine and mesentery and long pedunculated ovarian and uterine tumors have an almost unlimited range of mobility. The same is true for a movable spleen, but is rarely so for a tumor of the pylorus, kidney, or suprarenals. Retroperitoneal tumors arising from the pancras and glands have but little passive mobility. This also holds for inflammatory tumors like encapsulated exudates.

(*c*) The presence or absence of fluctuation.

(*d*) The consistency, size, and nature of the surface and edges of the tumor, and whether there is pulsation, genuine or transmitted.

III. *Percussion.*—This will aid in distinguishing ascites from an ovarian cyst, the former causing dullness in the flanks and tympany in the center, and the latter the opposite (Fig. 219).

Percussion will also help in distinguishing tumors with fluid or solid contents, and lying close to the abdominal wall, from those behind coils of intestine or the stomach.

IV. *Auscultation.*—This is of little value except in the differentiation of a pregnant uterus from other abdominal tumors or in the diagnosis of aneurysm.

Inflation of Stomach or Colon.—This is of great aid in the diagnosis of tumors of the stomach, large intestine, and of retroperitoneal tumors (kidney, pancreas, adrenals, lymph-nodes, etc.).

The results obtained from this method of diagnosis are described below.

TUMORS OF THE STOMACH.

These are almost always due to a carcinoma, rarely to a sarcoma or fibromyoma.[1]

[1] The subject of diagnosis of gastric carcinoma is taken up in detail on page 383.

The only forms of cancer of the stomach which can be felt through the abdominal wall are those which are situated at the pylorus alone or which involve the entire anterior wall as a massive infiltration.

Tumors of the stomach, especially those of the pylorus, show distinct respiratory, and a marked range of passive mobility (Fig. 220).

If the stomach is at a lower level, as the result of a gastroptosis or of a dilatation, there is but little respiratory mobility in the tumor. The same is true if adhesions exist.

Minkowski has shown that if one grasps a gastric tumor during inspiration and holds it, the expiratory upward movement can be prevented.

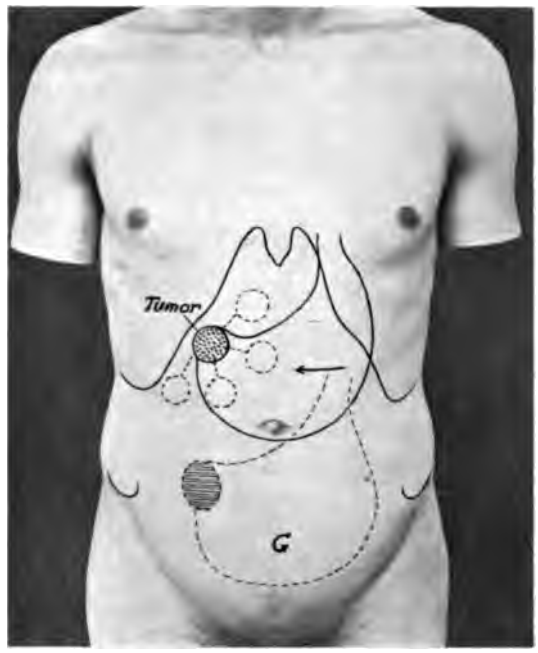


FIG. 220.—MOBILITY OF PYLORIC TUMORS.

The dotted circles of the upper figure represent the range of mobility of some pyloric tumors resulting from carcinoma of the stomach. The black arrow shows the direction of peristaltic waves. *G*, Location of stomach and of pyloric tumors in latter right iliac region, in cases of gastroptosis, or of extreme dilatation of the stomach.

Pyloric tumors move to the right and downward when the stomach is inflated, those of the anterior wall move downward, and both varieties become less accessible to palpation when the stomach is inflated.

Tumors of the stomach are most frequently felt in the epigastric and umbilical regions, but may be situated at a lower level if a gastroptosis or dilatation (Fig. 220) is present. This can be elicited by inflation. One can often cause peristaltic waves to pass across the stomach toward the tumor, if dilatation exists, by gently tapping upon the organ.

Gastric tumors are usually hard and smooth, but may be quite nodular. They are tender on palpation.

The diagnosis of whether such a tumor is a gastric carcinoma can be made if the accompanying symptoms referred to on page 383 are present, and by excluding the following forms of tumors.

Differential Diagnosis.—1. *Pancreatic Growths.*—The normal pancreas in elderly persons with thin, relaxed abdominal walls often feels like a gastric cancer.

Neoplasms of the head of the pancreas may also simulate carcinoma of the stomach. If the stomach and colon are both inflated, the pancreatic enlargements disappear (Fig. 221).

In pancreatic disease there is often an accompanying glycosuria, and stools containing free fat and undigested meat particles (see page 341). There may also be ascites, icterus, and hepatic enlargement (Figs. 225 and 226).

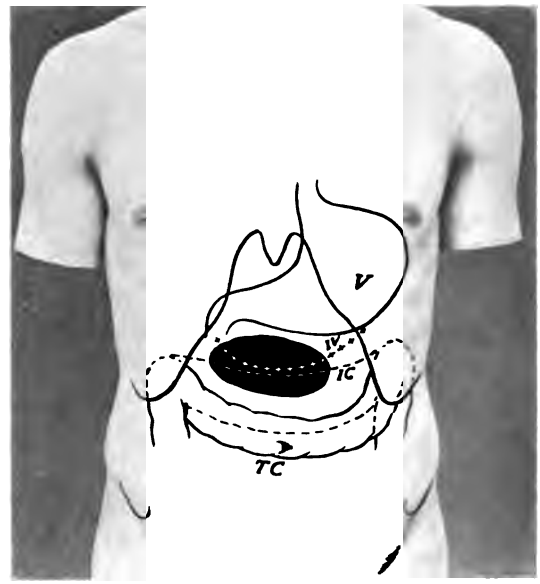


FIG. 221.—LOCATION OF PANCREATIC CYSTS BEFORE AND AFTER INFLATION OF COLON AND STOMACH.

V, Stomach before inflation; *TC*, location of transverse colon before inflation. The black oval area represents the pancreatic tumor, which may be quite prominent before inflation of the stomach and colon, but disappears when the latter procedure is used. The white dotted lines, *IV* and *IC*, represent the locations of the inflated stomach and colon respectively, overlapping the pancreatic tumor.

2. *Tumors of the Transverse Colon and Duodenum.*—Those of the former, cause obstruction symptoms. They disappear when the stomach is inflated, and become more prominent when the colon is inflated. In addition, there is an absence of pathologic change in the gastric contents analysis.

Tumors of the duodenum cannot be distinguished from those of the stomach, but while hydrochloric acid is absent in the vomitus of the latter, it is usually present in the vomitus of tumors of the duodenum.

3. *Carcinoma of the Gallbladder.*—Icterus is usually present. There is no lateral mobility and no respiratory fixation as described above. There are rarely any dyspeptic disturbances or signs of a dilated stomach. A history of previous gallstone attacks is usual.

4. *Tumors of the Left Lobe of the Liver.*—These become very prominent beneath the abdominal wall when the stomach is inflated (see page 334).

5. *Perigastritic Thickening Around an Old Ulcer of the Stomach.*—The induration may be so marked as to simulate a carcinoma. The course of the case is much slower, there is a history of ulcer, and the stomach contents will show hyperchlorhydria. It usually occurs in younger individuals, as compared with carcinoma, which is most frequent in the aged.

TUMORS OF THE LIVER.

I. Corset Liver.

Through the pressure of a corset, a lobule of the liver may become almost completely separated from the remainder of the organ and simulate other tumors of the upper abdomen. It occurs most frequently in the right lobe. A deep groove or furrow divides the liver proper from the supernumerary lobe which contains, instead of liver tissue, only blood-vessels and bile-ducts. The majority of these tumors cause no symptoms, but they become so far separated as to seem like a neoplasm having no connection with the liver. It may drag the gallbladder with it, just as does an elongated Riedel lobe (Fig. 187). As a result of this, the gallbladder may be found at the level of the umbilicus or even lower.

If the tumor is freely movable, or if the bridge connecting it with the liver is very thin, there may be great difficulty in diagnosis. The same is true for those cases in which a coil of intestine lies between it and the liver.

The diagnosis, in those cases in which the groove between the accessory lobe and the liver is not deep, is easy, if one can feel this transverse depression and observe that the tumor moves with the liver during respiration.

Differential Diagnosis.—*Floating Kidney.*—This can be better felt from the lumbar region, while the corset lobe is most distinct anteriorly. If the colon is inflated, it lies in front of the kidney (Fig. 230).

A movable kidney can be replaced upward and backward toward its normal position, and, on the other hand, can be pushed further down than the corset liver. If the patient is laid upon the left side, one can separate the sharp lower edge of the liver from that of the kidney, which is more rounded or blunt. If enteroptosis exists, the diagnosis may become very difficult, since movable kidney may be present at the same time.

Renal Tumors.—These often have the shape of the normal kidney and lie behind the inflated colon. The dullness over the renal tumor is not continuous with that of the liver, as in a corset lobe, but tympany

due to the overlying intestines exists. The lower edge of the renal tumor is not as sharp and lacks the notches often present in a corset lobe.

II. Floating Liver (Hepatoptosis).

A liver which has descended in the abdominal cavity may simulate a tumor of the right side. It may sink to the pelvis. It can usually be replaced into its normal position. On palpation, one can usually distinguish the sharp lower edge and the notch between the right and left lobes (Fig. 222). It is ten times as frequent in women as in men, especially in those with flabby, relaxed abdominal walls. The consistency of the tumor is that of the normal liver. The normal liver dullness is replaced by tympany, but reappears when the organ is put into its normal position. It may cause at times attacks of pain like biliary colic, radiating to the right shoulder. Usually it causes a feeling of fullness in the abdomen and digestive disturbances. The diagnosis may be very difficult if ascites coexists. It would be necessary to perform paracentesis first.

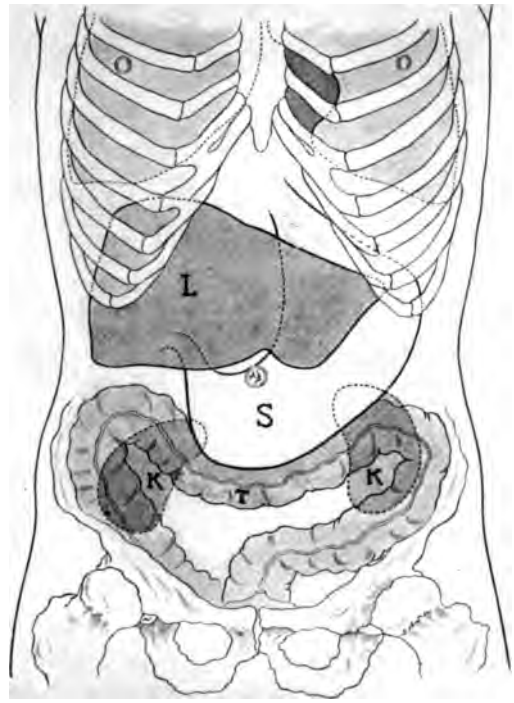


Fig. 222.—Front View of a Case of General Enteroptosis (R. C. Coffey).

L, Liver outline on surface, showing marked descent; S, stomach; note the fact that the lesser curvature lies at the level of the umbilicus, and the greater curvature midway between the umbilicus and symphysis; K, right and left kidneys, showing marked downward displacement; T, transverse colon, also markedly prolapsed.

Differential Diagnosis.—*Floating or Movable Kidney.*—The hepatic tumor is larger, more superficial, has the characteristic sharp lower edge of the liver and is notched.

The renal tumor has the outline of the normal kidney and lies behind the colon, when this is inflated (Fig. 230).

Tumors of the Liver Itself.—In carcinoma the surface is irregular and often umbilicated, and the liver, if enlarged much downward, also extends upward to its normal level at the sixth rib. The same is true for hydatid cysts.

Tumors and Cysts of the Omentum.—These, though movable, cannot be replaced to the same extent from above downward as a floating liver, and are separated by tympany (intestines) from the dullness of the normally placed liver.

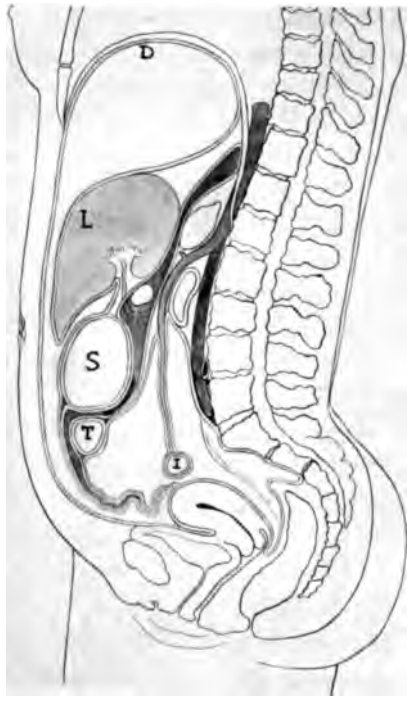


FIG. 223.—SAGITTAL SECTION IN MEDIAN LINE OF A CASE OF GENERAL ENTEROPTOSIS (R. C. Coffey).

D, Under surface of diaphragm; the blank space between D and L (liver) is the space formerly occupied by the liver before its descent; S, prolapsed stomach; T, prolapsed transverse colon; I, prolapsed coil of ileum; note elongation of the mesentery as the result of the prolapse.

III. ECHINOCOCCUS CYSTS OF THE LIVER.

This condition usually occurs in a unilocular form and is most often in the right lobe, causing a localized bulging on the surface and giving rise to a marked tumor. The liver is enlarged, and if the cyst is near the upper surface, it pushes the diaphragm upward. The normal liver dullness is increased upward in a circumscribed manner, as in a pleural effusion, but differs from it by having respiratory movement.

When the cyst lies near the lower border of the right lobe it causes a tumor, resembling a distended gallbladder or renal enlargement. When the cyst protrudes from the anterior surface of either the right or left lobe, it causes a marked localized bulging. These latter forms rarely give a sense of fluctuation, and the peculiar hydatid thrill, so pathognomonic when found, is an inconstant sign. The presence of echinococcus can be suspected from the presence of a localized tumor with absence of constitutional signs, such as fever, unless, as rarely occurs, suppuration has taken place.

The diagnosis can be positively made only if the characteristic scolices or hooklets are found in the clear, watery contents. Exploratory puncture is dangerous and should be replaced by a laparotomy for diagnostic purposes. An *x*-ray is of great aid in confirming a diagnosis of echinococcus if calcification has occurred.

Differential Diagnosis.—1. Echinococcus cysts of the anterior surface of the liver must be differentiated from the following:

(*a*) *Cystic Disease of the Liver.*—The elevations are usually small and multiple. If large, they can be differentiated from echinococcus cysts by exploration only.

(*b*) *Carcinoma.*—Here there is cachexia, umbilication of the tumors (Fig. 224), and the tumors are harder and multiple.

(*c*) *Abscess of the Liver.*—If no fever is present the differentiation may be very difficult, but in abscess the tumor is not so hard or tense. Usually, however, fever and other septic symptoms are present in hepatic abscess, and there is a history of dysentery to be obtained. If a hydatid cyst suppurates the diagnosis from primary liver abscess is almost impossible before operation.

2. When the hydatid cyst projects from the lower border.

(*a*) *From a Dilated Gallbladder.*—This tumor of the gallbladder is pear-shaped, it can only be separated from the edge of the liver with difficulty and is also more movable than an echinococcus cyst.

(*b*) *Permanent or Intermittent Hydronephrosis.*—In the intermittent form there is a history of alternating disappearance and presence of the tumor, the former associated with polyuria. A permanent hydronephrosis will have more or less the form of the normal kidney, project more in the lumbar region, and lie behind the inflated colon (Fig. 230). If the patient is laid upon the left side the echinococcus cyst is less prominent.

3. When the echinococcus cyst is on the upper border of the liver.

(*a*) *From Pleuritic Effusion.*—The diagnosis can only be made by finding the hooklets in the fluid removed by exploratory puncture. An upper border of dullness, not unlike that found in subphrenic abscess, occurs in the case of an echinococcus cyst of the upper surface of the liver; *i. e.*, the upper border is convex upward either in front or behind (Fig. 188), while in pleural effusion it is almost horizontal (Fig. 161).

(*b*) *From Hydatids of the Lung and Pleura.*—A differentiation is almost impossible if situated on the right side. Hemoptysis and cough are more frequent in hydatids of the lung.

(*c*) *From Subphrenic Abscess.*—Here the history of a primary cause of suppuration, *e. g.*, in the appendix, and the presence of fever, etc.,

are of aid. If the abscess contains gas there is tympany instead of dullness, and the *x*-ray will not show a shadow, as in hydatid. Exploration will reveal the absence of hooklets and the presence of pus.

IV. Cystic Disease of the Liver.

This condition, resembling congenital cystic disease of the kidneys (Fig. 231), is often present with the latter condition, and should be suspected if the liver and both kidneys are enlarged in a patient having uremic symptoms. The surface of the liver is nodular and some of the many cysts may be large enough to simulate hydatids. In such a case a differentiation is impossible without a microscopic examination of the wall of the cyst and its contents.

V. Syphilis of the Liver.

There are four forms of syphilis which are of interest from a surgical standpoint.

1. Cases of large gummata resembling neoplasms.

2. Cases of division of the right or left lobes or both into multiple lobules as the result of cicatrization following gummatous infiltration.

3. Cases with irregular fever and gumma formation resembling hepatic suppuration.

4. Cases resembling gallstones.

The first point in the case of gummatous enlargements is to identify the tumor as belonging to the liver, then to ascertain the presence of syphilis elsewhere or a previous history of the disease, and finally to observe the disappearance of the tumor under antisyphilitic treatment. If a gumma softens and fever is present, one cannot differentiate it from a hepatic abscess, in the absence of a syphilitic history.

The chief condition from which a lobulated luetic liver must be distinguished is floating kidney. The latter has a much greater range of mobility, has the form of the normal kidney, and can be best felt by bimanual palpation (Fig. 185). Inflation of the colon shows the tumor to lie behind the distended large intestine.

Rarely obstructive jaundice, with attacks of biliary colic, may follow the pressure of a gumma, or the traction of syphilitic cicatrices on the portal fissure (Rolleston, Billings).

Syphilis of the liver is often accompanied by a remittent temperature.

VI. Malignant Neoplasms of the Liver.

Sarcoma and carcinoma both occur as primary and secondary growths in the liver. The primary are quite rare and cannot be distin-

FIG. 224.—METASTATIC CARCINOMA OF THE LIVER SECONDARY TO THE PRIMARY CARCINOMA OF THE STOMACH SHOWN IN FIG. 245.

Note the umbilicated centers of each nodule. This illustration assists in forming a conception of the innumerable metastases from a comparatively insignificant primary carcinoma.

guished clinically from the secondary forms. The stomach (Fig. 245), colon, gallbladder, and breast (Fig. 173) are the most frequent seats of the primary growths, in cases having secondary cancer of the liver. Sarcomata are most often secondary to primary melanosarcomata of the uveal tract and of the skin.

The diagnosis of malignant disease may be made from the onset of cachexia, the rapid enlargement of the liver, and the palpable, hard, umbilicated tumors (Fig. 224) of the liver edge. In a patient who has a primary growth elsewhere, the diagnosis is positive; but in one in whom no such focus can be found, the diagnosis is a very probable one.

At times, especially in the case of primary sarcomata, one lobe may be enormously enlarged and its surface smooth and firm. From their location, such tumors can be diagnosed as being hepatic in origin, and inflation of the stomach will render them more prominent.

In addition to the above symptoms, there are marked jaundice (even cholemia with hemorrhages into the skin and from the mucous membranes), ascites, evidences of metastases in the peritoneum, and often febrile manifestations.

Differential Diagnosis.—1. *Cirrhosis of the Liver.*—The nodulation of the surface is never as marked nor is the surface as umbilicated as in carcinoma. If ascites is present, as is the case in both affections, the fluid should be removed before palpating the liver. The jaundice is not as deep in cirrhosis. Rapid enlargement of the liver and marked cachexia speak for malignancy. A search for a primary focus of cancer or sarcoma should always be made. The spleen is usually enlarged in cirrhosis, but is rarely so in malignant disease.

2. *Syphilis.*—Gummata are usually not as hard as carcinomatous nodules, there is a history of syphilis, and the constitutional disturbance is slight. The course is much more chronic.

TUMORS OF THE GALLBLADDER.

The two chief affections which might be mistaken for other abdominal tumors are hydrops and primary malignant disease of the gallbladder.

Hydrops.—Distention of the gallbladder occurs as the result of blocking of the cystic duct, followed by the accumulation of secretion and the formation of a tumor which varies greatly in size. It may quite movable or fixed by adhesions. There are three degrees of tention:

(*a*) Those in which the tumor is of relatively small size.

(*b*) Cystic tumors of great size extending to the left of the median line.

(*c*) Cystic tumors filling the greater part of the right side of the abdomen (Fig. 187).

The diagnosis in the first class may be made from the fact that there are but few subjective symptoms, although a history of one or more attacks of biliary colic is often obtainable. Its outline can often be seen through a thin abdominal wall. It can be felt to be attached to the liver above, is in close contact with the anterior abdominal wall, and has a wide range of mobility.

Palpation and percussion are often very unsatisfactory, for the reasons that unless adherent the tumor is so movable that it cannot be readily grasped, and, again, instead of dullness there is tympany from the underlying intestines. If the abdominal wall is quite relaxed, its lower rounded border may be distinctly felt as a tense elastic body, especially if one hand be placed posteriorly and the other in front, as in palpating the kidney (Fig. 185).

Inflation of the stomach makes the tumor more prominent and pushes it to the right, while inflation of the colon pushes it upward, unless, as rarely occurs, the colon is adherent between the tumor and the abdominal wall. Exploratory puncture is dangerous.

The larger forms of cystic tumors of the gallbladder which fill the greater part of the right half of the abdomen are infrequent, and can be recognized from the history, from their great mobility, smooth surface, their pyriform or cucumber shape (Alban-Doran), and the fact that they have their pedicle at the liver, instead of in the pelvis as ovarian cysts do. If adhesions exist there may be great difficulty in diagnosis. There is often distinct fluctuation in these large gallbladder retention-cysts.

Differential Diagnosis.—1. *Floating Kidney.*—This always retains the characteristic outline of the kidney. It can be replaced toward the renal region. Inflation of the colon causes it to disappear while the gallbladder tumor is pushed upward. There is tenderness on palpation, and pain when present radiates down the ureter or into the testis or thighs.

2. *Growths in the Stomach and Intestines.*—These can be distinguished by the difference in the symptoms and by the results of inflation of the colon and stomach.

3. *Echinococcus Cysts or Malignant Tumors Projecting from the Lower Edge of the Liver.*—These are much more irregular in outline, harder, and not movable except with respiration.

4. *Distention of the Gallbladder Following Cancer of the Pancreas.*—In this, it may distend to a quite marked size, but there are an accompanying cachexia, ascites, and deep jaundice (Fig. 225). Exploratory incision shows the head of the pancreas infiltrated and enlarged.

Malignant Disease of the Gallbladder.

This frequently follows cholelithiasis, and should be suspected if a hard mass is found in the right hypochondriac region following a history of gallstones in an elderly patient with persistent jaundice. The tumor is usually nodulated, rarely smooth, and is very hard in consistency. This induration, the nodular surface, and the rapid appearance of cachexia followed by icterus and ascites, serve to distinguish it from cholelithiasis; but in the latter the organ may be indurated so that a diagnosis is often not made until the abdomen is opened. The pains in cancer are not sharp and colicky, but of a dull character. If fever and colicky pains appear, they indicate an infection of the carcinomatous gallbladder. The course is a very chronic one.

PANCREATIC TUMORS.

Inflammatory tumors in the epigastric and umbilical regions due to peripancreatic suppuration following an attack of acute or subacute pancreatitis were referred to on page 311.

Other tumors due to pancreatic disease may be divided into three classes.

(*a*) Those due to chronic pancreatitis.

(*b*) Cysts.

(*c*) Neoplasms.

Chronic Pancreatitis.

The diagnosis of a chronic pancreatitis depends upon the cause. If due to obstruction of the common duct by a calculus, there will be a history of recurrent pain in the right hypochondrium with persistent or intermittent jaundice, as described on page 304. Fever of an irregular type, preceded by a chill and followed by a sweat, will usually accompany the attacks of pain as the result of a complicating cholangitis. Tenderness in the epigastrium is usually present and the pain often radiates to the left shoulder. If the chronic pancreatitis is the result of infection, without stones being present in the common duct, there may be only an epigastric dull pain. In both forms the loss of weight associated with

dyspepsia is marked. A definite train of symptoms begins which renders it possible to diagnose the chronic pancreatitis. In one case of the authors a distinct tumor could be palpated to the right of the median line, but in general a tumefaction is seldom found. Pain and tenderness, though usually present at this stage, may be little marked, but in some cases the pain is paroxysmal and severe and epigastric tenderness well pronounced. In the more chronic stages, especially when the disease has reached the cirrhotic stage, if the cause be not gallstones, a tumor of the gallbladder is found, similar to that met with in cancer of the pancreas (Robson and Cammidge).

The distention of the gallbladder is due to mucus and it is not sensitive on pressure, which is not apt to be the case when it is distended as the result of infection. Jaundice is usually present at some stage. In a recent case of the author's it was so marked and persistent as to lead to the erroneous diagnosis of common-duct stones. Jaundice is most apt to occur in chronic pancreatitis (not due to gallstones) when the common duct passes through the head of the pancreas, as it does in 62 per cent. of bodies. In chronic pancreatitis due to obstruction of the common bile-duct by a stone, the jaundice is frequently very marked in those cases (62 per cent.) where the common duct passes through or grooves the head of the pancreas. When the common duct passes behind the gland, as it does in 38 per cent. of bodies, the patency of the passage may not be seriously interfered with and little or no jaundice result. Dyspeptic disturbances are common in chronic pancreatitis. In the later stages the feces are pale, offensive, and very fatty.

The urine will give a more or less marked reaction, known as the Cammidge (see books on clinical diagnosis) test. An analysis of the feces will show an excess of unabsorbed fat. No single symptom can be relied upon, but on considering the pregressive wasting, the usual presence of jaundice, the dyspeptic disturbances, the pancreatic reaction in the urine, and the results of the chemical examination of the feces, a diagnosis can usually be made.

Differential Diagnosis.—1. *Gallstones in the Common Duct.*—In this condition there is the history of frequent attacks of biliary colic at first without jaundice, chills and fever, but later accompanied by these symptoms. The absence of tumors speaks also for gallstones in the common duct.

2. *Cancer of Head of Pancreas.*—The jaundice is deep and constant, the liver and gallbladder are greatly enlarged, and ascites is present. Emaciation is also more rapid. In some cases only exploratory [illegible] will aid in making a diagnosis. As mentioned above, palpati[illegible]

tumor will, at times, give misleading information, since the induration in choronic pancreatitis may be as great as in carcinoma. More reliance is to be placed on the presence of deep icterus and ascites, which speak for malignancy.

3. *Gallstones in the Gallbladder.*—There is tenderness over the gallbladder (Figs. 200 and 212) and the history of attacks of biliary colic.

FIG. 225.—FRONT VIEW OF CASE OF CARCINOMA OF THE HEAD OF THE PANCREAS.

The area of liver dullness is outlined in black. *R*, Right lobe of liver; *L*, left lobe of liver. The notch between the two lobes could be distinctly palpated to the left of the median line at the level of the umbilicus *G*, Enormously distended gallbladder easily palpable through the abdominal wall. Enormous size of the liver was due to passive hyperemia and to secondary deposits in the liver parenchyma. The yellowish color of the skin was due to pressure on the common duct.

The tumor is seldom as hard as that due to a chronic indurative pancreatitis and does not disappear when the stomach and colon are inflated, as the pancreatic induration does.

PANCREATIC CYSTS.

These cause a bulging in the median line of the epigastric region (Fig. 221) or between the middle line and left costal arch. In sixteen

cases Koerte found the tumor below the umbilicus, and in eleven cases Koerte and Neumann,[1] his assistant, have observed right-sided pancreatic cysts lying near the kidney (Fig. 230) and simulating renal tumors.

There is an area of dullness over the tumor. The epigastric bulging is smooth, tense and rounded, and may vary in size from time to time.

Such tumors have no respiratory or passive mobility, and inflation of the stomach and colon causes them to disappear, the former lying above and the latter below it (Fig. 230), unless one of the following rare positions of the cyst occurs:

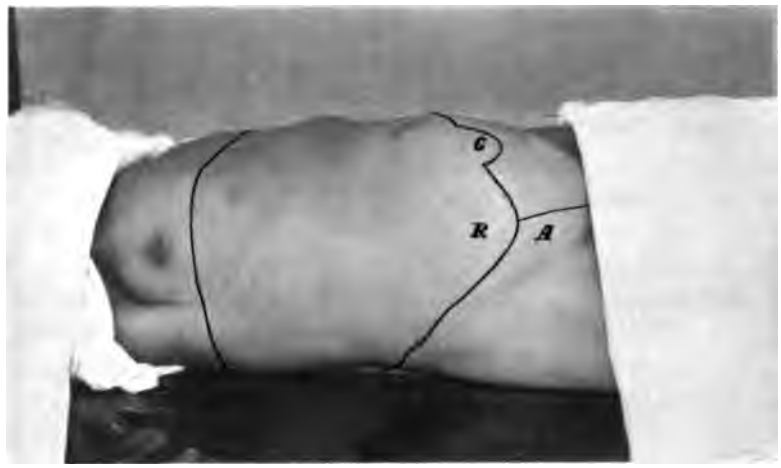


FIG. 220.—SIDE VIEW OF CASE OF CARCINOMA OF THE HEAD OF THE PANCREAS.

Yellow tint of flesh due to obstruction of common duct, as it passes through head of pancreas to reach the duodenum. *G*, Enormously distended gallbladder which could be distinctly felt through the abdominal wall. Its contents were cystic on account of the long-standing obstruction of the common duct. *R*, Lower border of right lobe of liver, which is enormously enlarged on account of secondary deposits. The upper level of liver dullness is shown just below the level of the nipple. *A*, Area of dullness due to free fluid in peritoneal cavity due to pressure upon portal vein.

(*a*) The cyst lies above the stomach and pushes the latter downward.

(*b*) It may be behind the transverse colon.

(*c*) It may lie below the transverse colon.

(*d*) It may lie behind the ascending colon (Fig. 230).

In these positions the cyst is often quite mobile.

The diagnosis may be made from the above special characteristics of the tumor, from the mode of onset, the accompanying symptoms, and the analysis of its contents when obtained at operation.

The modes of onset are chiefly three:

[1] "Deutsche Zeitschrift f. Chirurgie," Bd. lxxiv.

1. Gradual.—With loss of weight, symptoms of indigestion, and colicky pains like those of gallstones.

2. Sudden.—After blows on the upper abdomen.

3. No preceding trauma or symptoms mentioned under 1.

After the cyst begins to develop the patient may either have severe pain and vomiting or show no symptoms other than the gradually increasing distention of the abdomen. Jaundice, hematemesis, and diarrhea are occasionally present. In the urine sugar is often found; in the feces, an excess of fat and undigested meat may be found. The fluid should never be obtained for analysis by exploratory puncture, but only during a laparotomy. The most important diagnostic feature is that the fluid in a pancreatic cyst digests fibrin and albumin.

Differential Diagnosis.—*Echinococcus Cysts of the Liver.*—The tumor in these is continuous with the hepatic dullness, while in pancreatic cysts there is an area of resonance between the tumor and the liver, which is increased when the stomach is inflated. When the pancreatic cyst lies above the stomach these signs are of no value, but this form of pancreatic cyst is much more movable than is an echinococcus cyst.

Retention-cysts of the Gallbladder.—These were discussed on page 339. The chief points are their greater mobility and the continuation of dullness from the liver to the tumor.

Renal Cystic Tumors.—If, as shown in Fig. 230, the tumor lies behind the colon, a differentiation is impossible, and even after operation the fluid may fail to show any characteristic ferments in such cases. In general, however, renal tumors are accompanied by colicky pains along the ureter, by urinary changes, and give rise to more bulging of the ileocostal space. In the most frequent location of pancreatic cysts (Fig. 221) the colon when inflated lies below the tumor and not in front of it.

Ovarian Cysts.—When these have a long pedicle they may simulate a pancreatic cyst. The presence of both ovaries in the pelvis will exclude ovarian tumor.

Bimanual pelvic examination in the Trendelenburg position will show that the tumor has no relation to the ovaries. The history will show that the tumor first appeared in the epigastrium. Upon inflation of the colon, the ovarian lies below and the pancreatic cyst above it, except in those rare cases where these latter lie below the colon.

Mesenteric Cysts.—The history is of great value. Appearance of the tumor after an injury or following colicky pains speaks for a pancreatic cyst, as do fatty stools, glycosuria, undigested meat fibers in the feces, and emaciation. The mesenteric cyst is more movable, lies [illegible] umbilicus, and when the large bowel is inflated the transverse

colon lies across the tumor. Only when a pancreatic cyst has developed between the layers of the transverse mesocolon is differentiation impossible.

Neoplasms of the Pancreas.

Primary carcinoma of the head of the pancreas is the most frequent form of new-growth. The diagnosis may be made from the following symptoms:

1. Severe pain in the epigastrium, radiating through to the back. It is either continuous (a dull ache) or intermittent (agonizing).
2. Jaundice. This is present except in cancer of the body or tail.
3. Distention of the gallbladder and enlargement of the liver (Fig. 225).
4. Ascites.
5. Early cachexia.
6. A palpable tumor in the epigastrium which becomes less noticeable when the stomach is inflated.
7. Free fat and undigested meat fibers in large quantities in the feces.
8. Albuminuria—rarely glycosuria.

Differential Diagnosis.—1. *Gallstones in the Common Duct.*—The jaundice is more sudden in its appearance and often accompanied by irregular chills and fever. There is often a history of frequent previous attacks of biliary colic without jaundice and the gallbladder itself is tender to the touch. On inflating the stomach and colon the tumor will not disappear, as pancreatic tumors do. Ascites and cachexia speak for malignant disease of the pancreas.

2. *Chronic Pancreatitis.*—In the absence of ascites and jaundice, it is impossible to differentiate this from carcinoma except by the fact that in the latter there is early and much more marked cachexia. The induration in chronic pancreatitis often feels as hard at operation as in cancer of the head of the pancreas. In the latter, however, the condition becomes progressively worse, while in chronic pancreatitis it improves as soon as stones in the common duct are removed.

3. *Carcinoma of the Pylorus.*—The tumor is much more mobile than in cancer of the pancreas, there is a predominance of gastric symptoms with evidences of dilatation, and changes in the gastric juice. A cancer of the pylorus will not be accompanied by jaundice, ascites, and changes in the stool, and the tumor will move to the right when the stomach is inflated instead of becoming concealed, as does one of the pancreas.

4. *Carcinoma of the Colon.*—This may be accompanied by ascites,

but there are no changes in the stools, or jaundice, as in cancer of the pancreas. The tumor is more movable than that of the pancreas and does not disappear when the colon is inflated. There are often distinct stenosis symptoms.

TUMORS OF THE SPLEEN.

The normal spleen cannot be palpated except in very thin and relaxed patients and then only indistinctly. The conditions which most often give rise to splenic tumors are:

1. Floating spleen.
2. Splenic enlargements due to leukemia, pseudoleukemia, malaria, or acute splenitis.
3. Neoplasms, including echinococcus cysts.

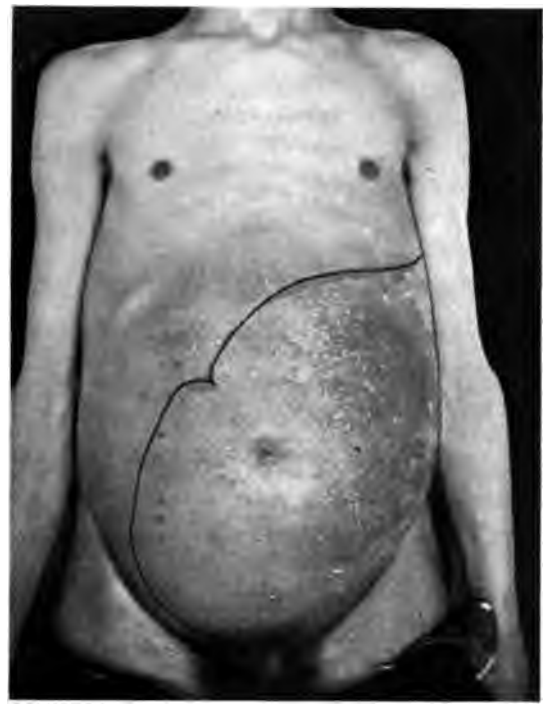


FIG. 227.—ENLARGEMENT OF ABDOMEN AS THE RESULT OF A LEUKEMIC HYPERTROPHY OF THE SPLEEN.

The dark color of the skin of the abdomen is due to the repeated application of the *x*-ray.

Floating or Wandering Spleen.—This condition is frequently present as a part of a general enteroptosis (Fig. 212), or is often associated with left-sided floating kidney. A tumor may be found which has caused practically no symptoms except a slight dragging sensation. Quite rarely the tumor may give rise to acute symptoms, such as pain, vomiting, muscular rigidity, and tenderness, due to strangulation or twisting of its pedicle.

A wandering spleen is most often found in the left iliac region, resting in the iliac fossa. Less often has it been found in the right iliac fossa and pelvis. In the latter situation it may cause obstruction.

A diagnosis is made by the palpation of the characteristic notches

(Fig. 227) along its anterior border, its smooth surface, and the absence of the spleen in its normal place. It can be distinguished from floating kidney by the fact that the latter can be replaced to the renal while the spleen disappears behind the costal arch unless held by adhesion. A floating kidney lies behind the colon, has the outline and rounded lower pole of the normal kidney, and in addition is much less movable than a floating spleen.

FIG. 228.—ANTERIOR VIEW OF THE CASE OF SARCOMA OF THE SPLEEN SHOWN IN FIG. 229 (W. E. Schroeder's case).

The outlines of the spleen have been marked with a dotted line. Observe the notches on the right margin of the tumor, characteristic of splenic tumors. E, Ensiform process in costal arch. Observe the formation of a well-marked caput medusæ.

Enlargements of the Spleen.—These are described at length in text-books of medicine. The writer has seen a number of cases in which such spleens, enlarged as the result of general diseases, such as leukemia (Fig. 227), pernicious anemia, pseudoleukemia, chronic malaria, and syphilis, have been mistaken for neoplasms of the spleen.

In every case of splenic enlargement of long standing one must remember the above causes and examine the blood or search for a cause elsewhere than in the spleen.

Another cause of enlarged spleen is that found in splenomegaly or Banti's disease, which may or may not be associated with anemia. For full descriptions of the various forms of this disease the reader is referred to the various treatises on internal medicine.

There are certain physical signs by which all of these enlargements may be recognized as splenic, viz.:

1. They retain the general outline of the spleen.
2. They have its notched anterior border.

3. They lie in front of the inflated colon and not behind it, as do renal tumors.

4. They have respiratory mobility.

(*a*) **Echinococcus of the Spleen.**—This is very rare and causes an enlargement of the spleen which can seldom be diagnosed before operation. Occasionally fluctuation may be felt and the tumor recognized as one of the spleen.

Sarcoma of the Spleen.—Both primary sarcoma and carcinoma of the spleen occur, but of the two, the former is the more frequent. The tumor occupies the left half of the abdomen, extending downward

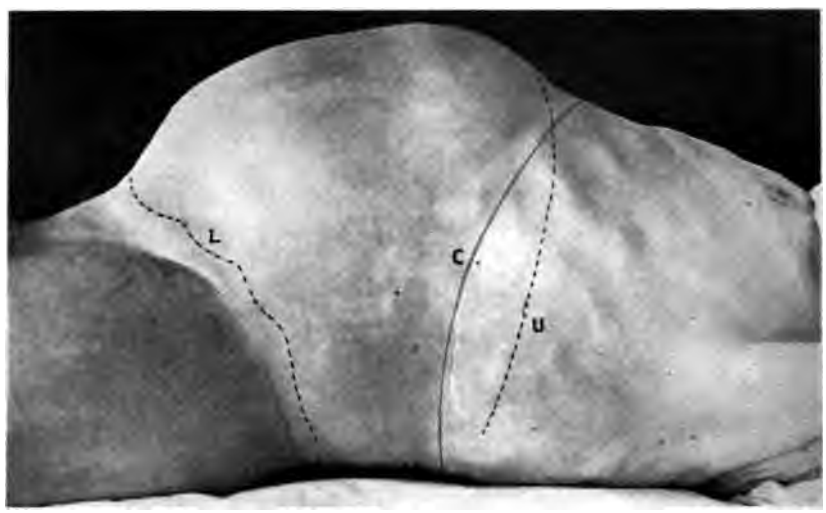


FIG. 229.—LATERAL VIEW OF ABDOMEN OF SAME PATIENT AS SHOWN IN FIG. 228, WITH SARCOMA OF THE SPLEEN (W. E. Schroeder).

L, Lower palpable border of tumor; U, upper border of tumor as outlined by percussion; C, costal arch.

from beneath the left costal arch (Fig. 228). It lies quite superficially, has a nodulated, hard surface, and often retains the characteristic notches of the anterior border of the spleen (Fig. 229). Its rapidity of growth, its hardness, and the accompanying cachexia are diagnostic of the malignant character of the tumor. It lies in front of the inflated colon and does not give rise to hematuria, as does a malignant renal tumor. It also causes early peritoneal metastases which can be felt as separate tumors.

TUMORS OF THE INTESTINES.

There are three places in the abdominal cavity where tumors which have their origin in the small and large intestine may be felt. These are, in the order of their frequency:

1. Rectum.
2. Sigmoid flexure.
3. Cecum and ascending colon.

The rarer seats of a tumor are the appendix, duodenum, ileum, and jejunum.

Unfortunately for the purposes of diagnosis, a palpable tumor is a rather late sign of malignant disease of the intestine, so that it should be made from the other signs and methods referred to on page 353. Those of the rectum are discussed on page 414. At this point the diagnostic points of intestinal tumors *per se* will be discussed whether due to neoplasms or inflammatory conditions.

1. **Inflammatory Tumors.**—These are the result of one of two affections, viz.: tuberculosis and actinomycosis. They are almost always found in the cecum. Quite rarely tumor-like inflammatory masses appear around the sigmoid as the result of perforation of the appendices epiploicæ.

(*a*) *Ileocecal Tuberculosis.*—The diagnosis frequently made before operation is that of a carcinoma. The tumor is quite fixed and more sensitive to pressure than a carcinoma, and is not quite as hard. There are also periodic attacks of severe pains, as the result of an enterostenosis, and alternating diarrhea and constipation is a quite common symptom. Rarely symptoms of acute intestinal obstruction arise. The disease occurs, as a rule, at an earlier age than carcinoma; there is often fever and it is not accompanied by as much emaciation as is the malignant process. The finding of blood in small quantities is more characteristic of carcinoma than of tuberculosis. In a recent article by Henri Hartmann[1] distinction is made from a clinical and pathologic point of view between (*a*) an enteroperitoneal and (*b*) a hyperplastic form of ileocecal tuberculosis.

Clinically, in the enteroperitoneal form, which is characterized anatomically by the presence of numerous ulcerations in the ileocecal region, with inflammation and even with pericecal suppuration, there is a groop of symptoms corresponding to the lesions. The patient has sometimes, at the beginning of the disease, signs of tuberculous enteritis; the stools are frequent, copious, liquid, and contain some blood. Attention is then attracted to the ileocecal region by acute pain in the right iliac fossa. This painful attack is sometimes the first symptom.

Such an attack may be due to appendicitis, and all the more if one is able to find a tumefaction in the iliac fossa. The rate at which the disease increases, as a rule, slower than appendicitis, and the tumefaction,

[1] "Revue de Chirurgie," February, 1907.

instead of diminishing after the acute period, persists. The disease generally progresses, the swelling becomes diffuse, extends to the median line toward the pelvis, and then becomes accessible to rectal or vaginal examination. A slow suppuration develops and discharges spontaneously through the skin above the femoral region. Here one or more fistulæ are found, through which a serous pus is discharged, mixed with fecal matter; these fistulæ extend sometimes as far as the umbilicus and lumbar region, etc. Sometimes these abscesses open into the intestine, and their evacuation is accompanied by purulent discharge per anum.

The general symptoms increase by the constant persistency of the suppuration, and also as the result of the evolution of a pulmonary tuberculosis, usual in these patients. Exceptionally the abscess bursts into the peritoneal cavity and death occurs within two to three days.

Clinically, the hyperplastic form, which is the more interesting form, has, as a rule, an insidious onset, with loss of appetite, slow digestion, and disagreeable but vague sensations in the right iliac fossa. For months this condition remains nearly stationary, improving sometimes temporarily after a course of appropriate treatment. Then the disease declares itself. The intestine becomes clogged, there is alternating constipation and diarrhea, sometimes attacks of colic two to three hours after meals, accompanied by local meteorism, peristaltism, and gurgling, which indicate generally the end of the attack. In other cases the signs of intestinal stenosis are less marked or even entirely absent. The attention is simply attracted by intermittent pains in the right abdomen, by recurrent acute attacks, simulating appendicitis. As a rule, the patient does not recover entirely in the interval. In some emaciated patients inspection shows a swelling; this may not be seen when the wall of the abdomen is thick or when there is slight meteorism or when of small size, but it can generally be felt. It is sharply outlined below, above it is continuous with the colon; it is slightly mobile and tender. Sometimes the tumor, instead of being in the normal position of the cecum, is higher up, at the upper part of the iliac fossa or even at the iliac crest.

The evolution of the hyperplastic process is slow, as the lungs are often intact for a long time. Gradually the obstruction advances, the general health is impaired, and emaciation becomes extreme. Sometimes the disease extends to the peritoneum and takes on some of the characteristics of the enteroperitoneal form. This is exceptional. The average duration of the disease is two and one-half to three years.

(*b*) *Ileocecal Actinomycosis.*—This localization of the ray-fungus gives rise to a tumor-like mass greatly resembling that of the hyperplastic variety of ileocecal tuberculosis.

According to Short,[1] who has collected 150 cases, the best clinical division is as follows: (1) Initial period of visceral manifestations. This consists of vague pains in the right iliac fossa, sometimes associated with intractable diarrhea. This may be muco-membranous in type. The pain may be severe, and relapsing appendicitis will probably be diagnosed. There are no local signs. (2) Stage of tumor formation. The characters are described in the next section. (3) Stage of fistula formation. Abscesses burst or are opened in the neighborhood of the original site, and dark, fetid pus discharges. In this the granules may be found, but they are very often absent, especially if the discharge is fecal. The best time to look for them is when a new abscess is opened. This stage usually lasts for months, subphrenic or pulmonary abscesses form, and the patient dies from hectic fever and exhaustion. In some cases, however, there is (4) a stage of cicatrization. The fistulæ close and cure results. This is often only temporary.

Before perforation has occurred, with formation of tumor, the diagnosis can only be made by finding actinomycetes in the stools. When in a patient over fourteen there is a history resembling appendicitis, and a large, very hard mass adherent to the deep structures and to the abdominal wall is felt in the right iliac fossa, but the temperature is not high, the pain is slight, and there has been little or no vomiting, actinomycosis should be strongly suspected. On such a clinical picture, added to the fact that eight years previously plastic adhesions had been found about the appendix, he diagnosed actinomycosis in his last case, and at the operation this proved correct. If, in addition, the skin is edematous, thickened, shiny, and of a purplish-violet, the probabilities are very great. Further, when after operation for appendicitis massive adhesions are found and secondary abscesses and fistulæ continue appearing for weeks afterward in the neighborhood, especially if a subphrenic abscess or abscess of the base of the right lung is suspected, actinomycosis should always be considered a very probable cause. Another point in diagnosis is the spongy character of the abscesses, so very little pus may be got from a large swelling. This is not present when there is a considerable secondary infection with pyogenic organisms. The actual confirmation of the diagnosis, of course, depends on the finding of the ray fungus.

Sometimes this affection may resemble tuberculous or malignant disease of the cecum, but in actinomycosis the mass is larger, more fixed, and there are no obstructive symptoms. It may also be confounded with psoas abscess.

2. **Neoplasms of the Intestines.**—Benign tumors are relatively

[1] "Lancet," Sept. 14, 1907.

rare and can seldom be diagnosed before operation. They give rise, if large, to symptoms of chronic stenosis and may cause intussusception. Of the malignant growths, sarcoma occurs in about 6 per cent. of the cases, the remainder being due to carcinoma.

The most frequent locations, according to recent statistics of Tuttle,[1] in 2432 cases, exclusive of the stomach, are as follows:

Rectum	1690 cases.
Cecum and ascending colon	283 "
Sigmoid	182 "
Transverse and descending colon	160 "
Appendix	60 "
Ileum, jejunum, and duodenum	69 "

The clinical picture varies according to the seat of the growth, but is generally that of a stenosis of the bowel.

Cancer of the Duodenum.—The symptoms are so closely allied to those of a pyloric cancer as to be indistinguishable, even when a tumor is palpable, which is usually not the case until late in the disease.

Cancer of the Remaining Small and Large Intestine except Rectum.—The diagnosis of cancer anywhere between the duodenum and rectum is usually to be made from a combination of certain general and local symptoms. The general signs are a gradually increasing anemia and cachexia for which no other cause can be found. These, when associated with intestinal disturbances in a person above forty, should always lead to the suspicion of a malignant growth. On the other hand, there are cases in which the general and local symptoms are so latent that a suspicion of malignancy is not aroused until a tumor which has all the physical characters of an intestinal one, is found during an abdominal or pelvic examination. Quite rarely cases of carcinoma of the intestine have an acute onset accompanied by fever, and a diagnosis is made only at operation, for what was thought to be an acute inflammatory condition. The chief local diagnostic points are:

1. *Symptoms of Stenosis.*—These are increased visible peristalsis and severe, griping, colicky pains, often referred to a particular spot and relieved as soon as flatus has been passed per rectum. Often, however, the patient does not pass any gas after these colicky pains, and this is quite characteristic of stenosis.

2. *Condition of the Bowel Movements.*—Obstinate constipation is present in the majority of the cases. This condition often alternates with diarrhea, which may be a prominent early symptom, especially

[1] "Medical Record," Nov. 4, 1905.

when accompanied by the frequent but unsuccessful desire to go to stool. The nearer the cancer is to the rectum, the more marked is this tenesmus. The feces may be ribbon-like if the stenosis is low down. The appearance of pus, blood, and mucus in the stools is of great value if a dysentery can be excluded.

3. *Tumor.*—The chief characteristic of intestinal tumors is their great mobility. This is especially true of those of the small intestine, sigmoid, and transverse colon, less so of those of the cecum or of the hepatic and splenic flexures. The latter can often be best felt by gradually pushing the hand under the costal arches.

The tumors are very hard and nodular. They may appear to be larger at one examination than at another, owing to the fact that feces collect on the proximal side, from time to time. The hardening of the tumor caused by the contraction of the hypertrophied musculature on the proximal side of the stenosis, followed by a gurgling sound due to passage of gas through the stenosis, may often be felt and heard.

Ascites may be an early symptom, accompanying a tumor of the colon.

Differential Diagnosis.—The conditions from which cancer of the small and large intestine must be differentiated depend upon their respective locations. They are as follows:

Those of duodenum and transverse colon....	Cancer of pylorus, of head of the pancreas.
	Tumors of omentum and mesentery.
Those of hepatic flexure.....	Cancer of gallbladder.
	Tumors of liver.
	Tumors of right kidney.
Those of splenic flexure.....	Tumors of spleen.
	Tumors of left kidney.
Those of cecum and appendix.....	Actinomycosis and tuberculosis of cecum.
	Post-appendiceal induration.
Those of sigmoid flexure.....	Tumors of ovary and uterus.
Those of jejunum and ileum.....	Non-malignant strictures.
Those of all parts of colon.....	From fecal impaction and gallstones.

TUMORS OF THE PERITONEUM AND MESENTERY.

Tumors of the Mesentery.—*Cystic Tumors.*—Cysts constitute the majority of mesenteric tumors; the proportion of solid to cystic tumors being as 1 to 4.

The smaller cysts have a wide range of passive mobility and rarely cause any symptoms. The larger ones cause a bulging in the umbilical region and are not as freely movable. These larger ones push the intestines aside and cause symptoms of stenosis, and in some cases even

complete obstruction. They may give the sense of fluctuation. These cysts may be of dermoid, hydatid, serous, bloody, or chylous nature, and are often adherent to the neighboring viscera.

Both the smaller and larger varieties of mesenteric tumors may be suspected from the presence of a tumor in the umbilical region, from the fact that they are not adherent to the abdominal wall like omental tumors, and, lastly, their extreme mobility, except when very large.

They must be differentiated from the following:

Tumors of the omentum	These are usually adherent to the anterior abdominal wall.
Pancreatic cysts	These show some disturbance in the pancreatic secretion and lie behind the inflated stomach and colon.
Retroperitoneal cysts	These are immovable and lie behind the inflated colon.
Ovarian cysts	By elevating the pelvis, one can feel the pedicle of these tumors connected with the uterus.
Movable kidney and hydronephrosis	These retain the outline of the kidney, lie more laterally, and behind the colon.
Encapsulated tuberculous peritonitis	This may greatly resemble a mesenteric cyst as shown in Figs. 234, 235, but when the patient lies down the enlargement tends to become flatter, while the cysts retain their convex surface.

Tumors of the Omentum and Peritoneum.—These, as in the case of the mesentery, are either cystic or solid. Both become adherent quite early to the abdominal wall. Echinoccocus cysts constitute the most frequent variety of cystic tumors, while carcinoma occurs most often in the form of a solid tumor. Carcinoma may occur both as a primary and secondary growth. The latter follows cancer of the stomach and intestine. The diagnosis may be readily made if there is a history of a primary growth; but if there is none, it must be made from the presence of certain symptoms.

Lipomata are the most frequent form. They do not fluctuate, although they may yield a sense of pseudo-fluctuation. They grow quite rapidly and cause early stenosis symptoms.

If the omentum is chiefly involved, a transverse, very hard tumor is to be felt at or above the umbilicus. It is adherent to the anterior abdominal wall and accompanied by ascites and progressive emaciation. Multiple hard tumors are to be felt, if the parietal peritoneum is also involved, and these are accompanied by ascites.

The transverse tumor may occur both in tuberculous and simple proliferative peritonitis. These, however, occur at a younger age

than does carcinoma and emaciation is not nearly as marked. The nature of the fluid in cancer is usually hemorrhagic, but this may also be the case in tuberculous peritonitis.

TUMORS OF THE KIDNEY.

The best method of examination of tumors of the kidney is by palpation of the abdomen, with the patient in a recumbent position, the knees flexed and shoulders elevated (Fig. 185), one hand placed over the corresponding renal region, while the other presses the abdominal wall in gradually but firmly, using the entire palmar surface of the hand and not the finger-tips alone.

Another method which is not as frequently used is that recommended by Israel, which consists in having the patient lie upon the healthy side while the renal region is palpated bimanually on the diseased side. In patients who are not too stout, and whose abdominal walls are relaxed, the lower pole of the kidney may be normally felt a little above the level of the umbilicus at the external border of the rectus abdominalis.

Abdominal tumors which are due to abnormal conditions of the kidney may be divided into four classes:

1. Congenital displacements and malformations of the kidney.
2. Movable kidney.
3. Diseases which are accompanied by enlargement of the kidney, such as hydronephrosis, pyonephrosis, pyelonephritis, tuberculosis, nephrolithiasis, and neoplasms.
4. Tumors which are due to neoplasms of the kidney.

1. Congenital Displacements and Malformations of the Kidney.

(*a*) It is practically impossible to diagnose a congenital displacement of the kidney before operation. Such kidneys do not give rise to symptoms unless enlarged through inflammation, and their presence in such abnormal places as the pelvis is seldom suspected. I have seen two such cases. In one of these the kidney was located over the promontory of the sacrum, and caused some pain, the etiology of which was not clear until the kidney was discovered at operation. In the second case the congenitally displaced kidney was found incarcerated between the pregnant uterus and the rectum and was the cause of the severe dystocia. One may suspect that an abdominal tumor is a congenitally displaced kidney if ureteral catheterization is performed and it is found impossible to catheterize the ureter upon the side of the suspected kidney tumor. Such obstruction may be due to other causes, such as

stricture of the ureter, etc., and the diagnostic value of ureteral catheterization is therefore not great.

(*b*) Congenital malformations of the kidney, such as horseshoe kidney, cannot be diagnosed before operation, unless some change such as a hydronephrosis supervenes, when it may cause a tumor lying transversely at the middle of the pathologically situated kidneys, which can be diminished by compression and which is found to be retroperitoneal. In a recent case of the author's an hour-glass-shaped tumor could be felt lying at a deep level transversely across the abdomen a little above the umbilicus. The diagnosis could, however, not be made before operation, which latter revealed a horseshoe kidney, with development of a congenital hydronephrosis upon one side.

2. Movable or Floating Kidney.

Eighty-five per cent. of movable kidneys occur in women. The diagnosis may be made from the presence of a movable tumor having the typical form of the kidney, with convex outer and concave inner borders, and the round, blunt, lower pole. This tumor, like all renal tumors, usually lies behind the inflated colon. It can be readily brought to the anterior abdominal wall and then can be replaced toward the renal region. An interesting point is that such abnormal mobility is often associated with a general splanchnoptosis.

In addition to the tumor itself, the cases may be divided clinically into three classes:

(*a*) Those in which the tumor is not accompanied by any symptoms referable to the kidney.

(*b*) Those in which the symptoms are those of a drawing pain in the lower abdomen and lumbar region, which may become colicky and radiate down the ureter, accompanied by evidences of nervous dyspepsia and constipation. The pain decreases when the patient lies down.

(*c*) Those cases which, in addition to the tumor, give the history of recurrent attacks which have been termed "Dietl's crises," and described on page 213. Such an attack is characterized by severe pain, chill, nausea and vomiting. The pain radiates along the ureter. There is but little urine passed during the attack, but following it there is the passage of a large quantity of urine in a short time. During the attack itself the kidney may be greatly enlarged and tender, but this disappears with the acute syndrome. The urine contains red blood-cells in moderate quantity after the attack, and not during it, as occur in renal colic.

Differential Diagnosis.— a Movable kidney must be differentiated from a *cirrhotic liver*. This is very difficult if they are both present on the right side. Diagnosis is aided by laying the patient on the opposite side, as recommended by Israel, when one can separate the lower edge of the liver, which is always more or less sharp, from the kidney.

(b) From the *cystic tumors of the liver* and *enlarged gallbladder*. These have a distinct respiratory mobility, and are much nearer the surface than a kidney. They cannot be replaced into the renal region like a floating kidney, and the tumor itself is continuous with the liver, while in the case of the kidney, especially when the colon is inflated, there is an area of tympany between the tumor and the kidney.

(c) Tumors of the Colon and Stomach.—Here the history of the case will show either the symptoms of a pyloric stenosis or an enterostenosis, and there will be more or less emaciation. The inflation of the colon or of the stomach will show more accurately the relation of the tumor to these structures, and in the case of the pyloric tumor, examination of the stomach contents will throw additional light.

(d) Pedunculated Ovarian and Uterine Tumors.—Their connection with the uterus through the ovarian ligament can be determined by bimanual examination; the floating kidney shows the characteristic form and can be readily replaced.

3. Diseases of the Kidney which are Accompanied by Enlargement.

Pyonephrosis and pyelonephritis have been discussed on page 278. Tuberculosis and nephrolithiasis are taken up on pages 417 and 420.

Hydronephrosis.—This causes a tumor which is either constantly prominent, or is intermittent in its presence. This latter form is most often accompanied by floating kidney, recognition of which enables the diagnosis of the condition. The hydronephrotic enlargement of the kidney, like all renal tumors, appears from beneath the costal arch in the lateral aspects of the abdomen. Bilateral palpation enables the tumor to be brought either nearer to the abdominal wall or to become more prominent posteriorly in the space between the last rib and the crest of the ilium. If the hydronephrosis is a recent one, the tumor itself is firm. If it is of longer duration, distinct fluctuation may be found. The tumor lies behind the inflated colon, has a marked degree of mobility, and its surface is uniformly smooth.

The *differential diagnosis* of this form of renal enlargement has been discussed under the subjects: echinococcus of the liver; cystic enlargement of the gallbladder; cysts of the pancreas; ovarian tumors; tumors of the spleen, and neoplasms of the kidney, from all of which it must

be differentiated. In renal tumors it may be said, in general, that they lie behind the colon, and this assists in the diagnosis.

4. Renal Neoplasms.

Neoplasms of the kidney which may be recognized clinically are of two varieties:

1. Polycystic kidneys (Fig. 231).
2. Malignant tumors.

1. Polycystic Kidneys.

The diagnosis may be made from the association of one or more of the following symptoms and physical findings.

(*a*) The presence of bilateral tumors with nodulated surfaces, having all of the characteristics of renal tumors as given on page 356. Quite rarely a tumor is only to be felt on one side. A palpable tumor is present in 25 per cent. of all cases.

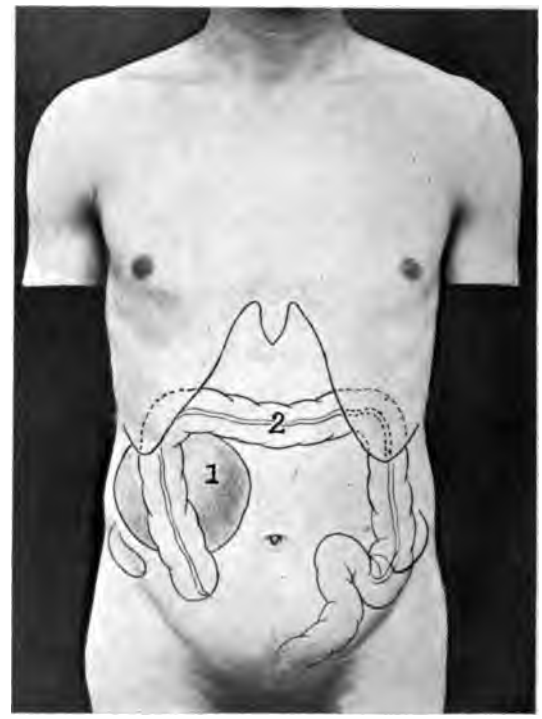


Fig. 230.—Relations of Renal Tumor of Right Side to Inflated Colon.

1, Renal tumor; 2, transverse colon; the inflated ascending colon lies in front of the tumor. A similar retroperitoneal condition may be due to unusual position of a pancreatic cyst simulating a renal tumor.

(*b*) The symptoms of a chronic interstitial nephritis, viz., high-tension pulse, cardiac hypertrophy, large quantities of urine with low specific gravity containing a trace of albumin and few casts. Rarely uremic coma occurs.

Differential Diagnosis.—These cases can be differentiated from *chronic interstitial nephritis* with attacks of hematuria by the fact that the hematuria in nephritis is never as severe as in polycystic disease, and the further fact that in the latter bilateral, palpable tumors are present in 25 per cent. of the cases.

From *hydronephrosis* it can be distinguished by the unilateral occurrence, the smooth surface and greater regularity of a hydronephrotic tumor.

2. Malignant Tumors.

The diagnosis of a malignant neoplasm of the kidney may be made from a consideration in each case of five factors which vary greatly in value and in frequency.

These are:

1. Hematuria.
2. Pain.
3. Tumor.
4. Cachexia.
5. Metastases.

1. *Hematuria* occurs in about 70 per cent. of all cases as the first

FIG. 231.—EXTERNAL VIEW OF CONGENITAL CYSTIC KIDNEY. (See page 359.)

symptom, and is especially frequent in hypernephromata. The hemorrhage occurs spontaneously, independent of exercise, may be quite large in amount and last for months. Quite often casts of the ureter, in the form of worm-like clots, are found in the urine.

The hematuria of renal calculus is increased or caused by exercise, is never as great in amount as in tumor, does not last as long, and is usually accompanied by colic.

In tuberculosis the hematuria is small in amount, not influenced by exercise, and accompanied by pus and tubercle bacilli in the urine.

The hematuria of polycystic kidney is rarely as profuse as that of malignant tumor and does not last as long and is accompanied by the signs of high vascular tension and polyuria.

Hematuria in chronic nephritis is rarely as marked; there are never worm-like clots, and one finds, in addition, the cardiovascular changes characteristic of this disease.

It is impossible to distinguish the hematuria known as *essential* or *idiopathic* from that due to malignancy unless tumor or cachexia is present. This form of hematuria, however, runs a more chronic course.

2. *Pain.* This is very rarely the first symptom. When present, it is of a dull, dragging character, referred to the lumbar regions and radiating to the thigh. During an attack of hematuria the passage of the worm-like clots causes typical renal colic in the case of renal tumors.

3. *Tumors.* The majority of cases in adults are hypernephromata or sarcomata, while in children the latter form predominates. The physical characteristics of such renal tumors may be summed up as follows:

(*a*) The colon when inflated, lies in front of, or on the inner side of the renal tumor. The latter may be pushed so far inward by a large mass that there is no tympany over the tumor when the colon is inflated (Fig. 230).

FIG. 232.—ANTERIOR VIEW OF A CASE OF SARCOMA OF THE KIDNEY IN A BOY OF FIVE (case of Dr. I. A. Abt).

K, Outline of kidney; L, outline of greatly enlarged liver.

(*b*) The tumor can best be palpated by the bimanual method shown in Fig. 185. By alternately raising the posterior and depressing the anterior hand during expiration, the size, consistency, and character of the surface may be ascertained. A second method is to lay the patient on the healthy side and then palpate bimanually.

(*c*) The general outlines of the kidney may be retained. These are

the concave inner and convex outer borders, and the blunt, rounded, lower pole.

When the tumor is quite localized in the lower pole, or very large, the resemblance to the normal shape is absent.

(*d*) Renal tumors cause a fullness in the space between the last rib and the crest of the ilium (iliocostal space). They lie nearer the anterior abdominal wall than does the normal kidney.

(*e*) The tumor may be so large as to occupy almost the entire abdominal cavity, as in the case shown in Figs. 232 and 233, so that it is impossible to determine from which organ the tumor has its origin.

(*f*) Benign tumors, with the exception of single and multilocular cysts, seldom give rise to palpable tumors. Malignant tumors cause an irregular round mass with a nodular surface and rapid growth. If

FIG. 233.—SIDE VIEW OF SAME CHILD SHOWN IN FIG. 232 (SARCOMA OF THE KIDNEY).
K, Outline of kidney on the abdominal wall; L, left edge of enlarged liver.

retrograde changes or softening are marked, the tumor may feel like a cystic one.

(*g*) Renal tumors when small have a moderate range of passive but practically no respiratory mobility.

4. *Cachexia.* This is usually not marked until the tumor attains a large size (Fig. 232). Emaciation is more rapid and marked in children (Fig. 232) than in adults. One must distinguish the marked anemia resulting from hematuria from a cachectic condition. Occasionally a renal tumor is accompanied by quite marked elevations of temperature.

5. *Metastases.* There are no symptoms which are characteristic of the growth of the renal tumor into the renal vein or vena cava. One should always bear in mind the tendency of malignant tumors to locate secondary foci in bones. This must always be thought of when symptoms occur, referable to the extremities, in a patient suffering

from hematuria and cachexia, since the metastasis may be the first symptom.

Differential Diagnosis of Renal Neoplasms.—1. *Retroperitoneal Sarcoma.*—These lie nearer the median line and cause but little displacement of the colon. When they are large they may involve the kidney so that a differentiation is impossible.

2. *Ovarian Tumors.*—The pedicle may often be felt to be connected with the uterus or adnexa. The intestines lie above and to its outer side (Fig. 219). The ovarian tumor, unless very large, can be traced to the pelvis, while a renal tumor appears to come from beneath the costal arch and causes bulging of the loin.

3. *Splenic Tumors.*—These, if large or when the characteristic shape is obliterated, may be impossible to differentiate (Fig. 228). If smaller, the characteristic notched edge and smooth surface aid in distinguishing them. In addition, the splenic tumor lies in front of the inflated colon and is not accompanied by hematuria.

4. *Tumors of the Liver.*—When the renal tumor is moderately large a zone of resonance is found between it and the liver. The renal tumor causes more bulging of the lateral aspects of the abdomen, is accompanied by hematuria and blood-casts of the ureter. Hepatic tumors lie more anteriorly and in front of the colon, unless the latter is adherent to their anterior surface.

RETROPERITONEAL TUMORS.

Tumors of the pancreas and kidney have been considered on pages 344 and 356 respectively. The remaining varieties of retroperitoneal tumors are (*a*) lipomata; (*b*) cysts; (*c*) sarcomata.

(*a*) *Lipomata.*—These are among the relatively more common new-growths. Although they are not malignant, they are fatal to life, on account of the enormous size which they attain, pushing adjacent organs aside. Such patients complain of a slowly growing tumor, steady emaciation, and dyspnea. In some cases there is edema of the lower extremities, intestinal or gastric indigestion from pressure of the growth. At times there is vomiting or diarrhea or vesical disturbances. Examination will show a tumor generally upon one side of the median line, which is semifluctuating and lobular, or, if fibrous, it will be hard and nodular. Mobility from side to side may be present. The transverse colon is apt to lie in front of the tumor, but the stomach may be pushed far to the side, together with the small intestines. Lipomata must be differentiated from retroperitoneal cysts and sarcomata, tumors of the pancreas and kidney, etc.

(*b*) *Cysts.*—The origin of these may be from the pancreas or be chylous, or they may be due to the echinococcus, or to a retroperitoneal hematocele, or, finally, some belong to the teratomata. Mesenteric cysts may also originate here.

Pancreatic cysts are described on page 344. Chylous or lymph cysts may form large tumors in any portion of the abdomen. They contain a turbid or milky fluid. Blood cysts may start from injury, from hemorrhage in hemophilia. They form rapidly in any part of the abdomen. Blood cysts involving the iliopsoas are not rare. The symptoms simulate those of tuberculous hip disease (page 725). Echinococcus cysts occur less often than in the peritoneal cavity. The teratoid tumors vary from simple dermoids to the most complex, containing hair, bones, etc. They may reach enormous size. The diagnosis of these various cysts is not easy. The presence of a tumor, tense and fluctuating, which displaces the stomach and intestines, combined with evidences of pressure upon the circulation, as shown in dilated veins (Fig. 228), ascites, anasarca, should lead to the suspicion of a retroperitoneal cyst. The colon and stomach should be insufflated in order to bring out their position. Aspiration is not justifiable.

(*c*) *Sarcomata.*—These may be primary or secondary. In the latter, the primary growth can usually be found in the ovaries, testis, prostate, or lower extremities. The primary tumors may start from the fascia, periosteum, glands, vessel-sheaths, or from a misplaced organ or genito-urinary rest. The rate of growth of these primary sarcomata is more rapid than that of the lipomata, but they do not attain so great a size. The diagnosis is very difficult. Obscure digestive symptoms, associated with rapid loss of weight and deep-seated tumors, are the chief factors in the diagnosis. Intestinal obstruction of varying degree is also present. The viscera are displaced as in a lipoma (page 363), and one can usually ascertain that the growth is retroperitoneal by insufflating the colon (Fig. 230), whereby it will be found in front of the growth.

ASCITES.

The presence of free serous fluid in the peritoneal cavity may either simulate or obscure the existence of abdominal tumor so that it is necessary to recognize the physical signs caused by such fluid. These are:

1. Widening of the abdomen.

2. A wave-like impulse, upon tapping with the fingers of one hand, felt by the other hand laid flat upon the opposite side of the abdomen.

While the patient is lying on his back percussion shows the median portions to be tympanitic (Fig. 219). This is the opposite of the percus-

sion findings in ovarian cyst (Fig. 219), unless the latter is accompanied by ascites. When the patient lies on one side, the opposite flank becomes tympanitic, but this changes to dullness when he is rolled upon his back again.

The diagnosis of an ascites is confirmed by inserting a trocar in the median line midway between the navel and symphysis pubis, and obtaining a clear straw-colored fluid of low specific gravity containing a small amount of albumin.

In tuberculous and carcinomatous processes the fluid is at times hemorrhagic, but this is inconstant. In these cases a multilocular condition may exist and more than one puncture may be necessary to obtain the fluid. In chylous ascites the fluid is milky.

Having ascertained the presence of an ascites, one must attempt, either before or after the removal of the fluid, to determine its cause. This may be local or general.

FIG. 234.—THE AREAS OF DULLNESS IN A CASE OF ENCAPSULATED INTRAPERITONEAL FLUID.

This illustration is the front view of the patient shown in Fig. 235. 1, Indicates the size of the encapsulated abscess, which was of a tuberculous nature, lying between the abdominal wall and the agglutinated coils of intestines within the peritoneal cavity, extending upward between the right lobe of the liver and the thoracic wall. 2, Indicates the area of external prominence on account of which the case was at first thought to be one of hydronephrosis.

Local causes:

(*a*) Obstruction of the portal circulation, due to:
Cirrhosis of the liver.
Neoplasms of the liver.
Abdominal tumors which compress the inferior vena cava or portal vein.

(*b*) Tuberculous or simple proliferative peritonitis.

(*c*) Neoplasms of the peritoneum.

(*d*) Tumors of the abdomen—especially ovarian cysts, uterine fibroids impacted in the pelvis, etc.

(*e*) Obstruction of receptaculum chyli or duct leading from it. Traumatism to the receptaculum chyli may cause a chylous ascites, as in a case reported by Dr. W. E. Morgan.

General causes:

(*a*) Cardiac affections.

(*b*) Renal diseases.

(*c*) Chronic pulmonary diseases such as emphysema or sclerosis.

TUMORS DUE TO INFLAMMATORY EXUDATES OR TO TUBERCULOUS PERITONITIS.

Tumor-like masses may follow many of the acute and chronic abdominal affections, especially appendicitis and inflammations of the female pelvic viscera. The tumor-like induration around some gastric ulcers is referred to on page 383. Massive exudates often bind adjacent coils of intestine together in such a manner as to closely simulate neoplasms on palpation. The history of a preceding inflammation is of the greatest aid in making a diagnosis in these cases. Often some tenderness and muscular rigidity coexist.

Tuberculous peritonitis is more fully discussed on page 399. It may give rise to tumors simulating those having their origin from the various viscera referred to in this section in one of four ways.

(*a*) Encapsulated exudates (see Figs. 234 and 235).

(*b*) Through puckering of the omentum. This causes a transverse, hard, elongated tumor, lying just above the umbilicus, although it has been found in the right iliac region.

(*c*) In an occasional case, after an ascites has been tapped one can feel the tumor due to contracted and adherent coils of intestine (Fig. 236).

(*d*) The presence of tumor-like masses in children due to enlarged tuberculous mesenteric glands with or without accompanying ascites.

The diagnosis may be made if there are tuberculous foci elsewhere, especially of the cervical lymph-nodes. When this is accompanied by emaciation and evening rise of temperature, the diagnosis is rendered almost certain, but both of these may be absent, as in the case shown in Figs. 234 and 235. The tumors are often accompanied by pains and digestive disturbances in tuberculosis. One should never omit a rectal and vaginal examination. The history of tuberculous environments or of eating the flesh or milk of tuberculous cattle is of value also.

TUMORS DUE TO ANEURYSMS OF THE ABDOMINAL AORTA OR ITS BRANCHES.

Aneurysms of the abdominal aorta and its larger branches may give rise to palpable tumors which, in general, are readily recognized. When grasped between the thumb, on one side, and the fingers on the other (Fig. 451), these tumors have an expansile pulsation and a systolic thrill. Auscultation shows a systolic murmur. These signs may, however, be rather indistinct if the aneurysmal sac is nearly obliterated. Under such circumstances the tumor can be recognized as being aneurysmal only by exclusion (Fig. 237).

In the majority of cases it is impossible to diagnose aneurysms of the cœliac axis, or its branches, or of the renal arteries. When palpable, however, they show the same signs as do those of the aorta.

The writer recalls one case of aneurysm of one of the branches of the superior mesenteric artery which caused a very mobile tumor whose nature was not recognized before operation.

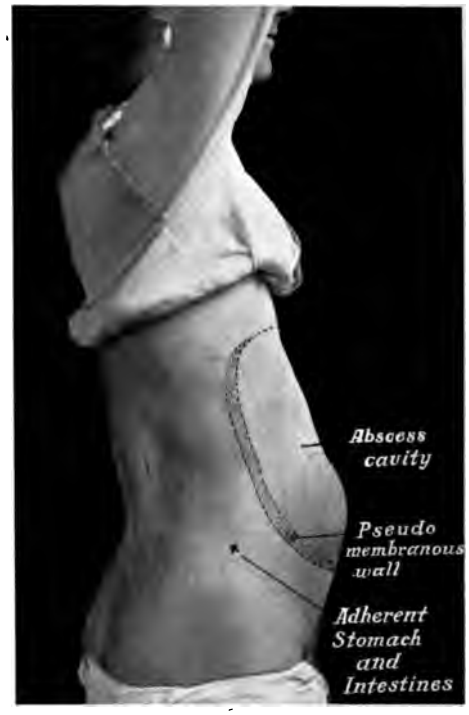


FIG. 235.—ENCAPSULATED TUBERCULOUS PERITONITIS.

Shaded area indicates the false membrane found at the time of operation, which separated the abscess cavity from the stomach and intestines, which were adherent to each other, and pushed to the posterior and left portions of the abdominal cavity. This is the side view of the same case represented in Fig. 234.

Aneurysms of the iliac arteries are often easily palpable (Figs. 237 and 238). Those of the external iliac cause a firm, immovable tumor in the iliac fossæ whose nature can be determined by the presence of the characteristic expansile pulsation, of a thrill and murmur.

Differential Diagnosis.—An unusually marked pulsation of the abdominal aorta occurring in neurasthenics is often erroneously diagnosed as an aneurysm. It lacks the typical expansile pulsation of an aneurysm and the thrill is absent.

Tumors of the pylorus or pancreas lying over the abdominal aorta

may have apparent pulsation through the transmission to them of the arterial movements. When the patient is placed in the knee-chest position, these tumors of intraperitoneal origin lose this pulsation.

They lack the expansile character of aneurysm, and one can usually recognize their nature by the other signs, such as the tests, etc., described.

Pulsating tumors filling up the entire iliocostal space and lateral abdominal regions are usually due to the rupture of an abdominal aneurysm into the retroperitoneal tissues.

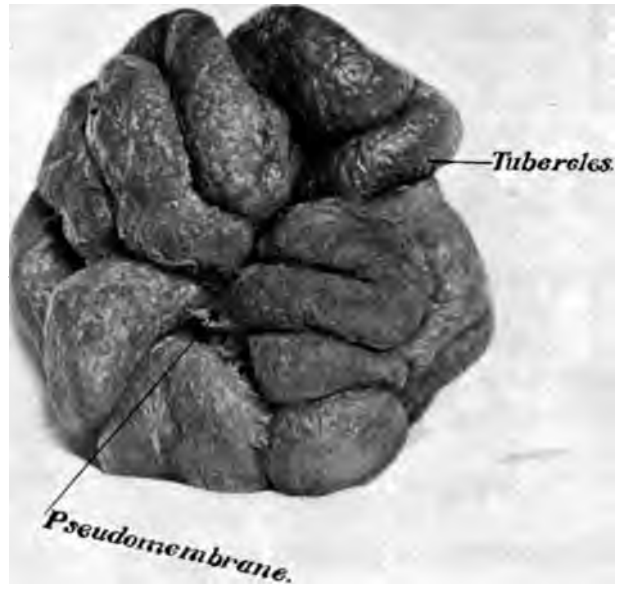


FIG. 230.—COILS OF INTESTINE IN A CASE OF TUBERCULOUS PERITONITIS.

The label pseudomembrane leading to a cross shows how these false membranes bind the different coils of ntestine to each other. The serous surfaces of the various coils show innumerable tubercles covered by this false membrane.

ABDOMINAL TUMORS HAVING THEIR ORIGIN IN THE PELVIC VISCERA OR BONES.

Only those tumors are mentioned in which the enlargement is sufficient to cause the growth to rise out of the pelvis.

1. **Distended Urinary Bladder.**—In both sexes the enormously distended urinary bladder (Fig. 217) has been mistaken for a neoplasm or an encapsulated collection of fluid. Ascites, an encapsulated exudate, and ovarian cysts are also among the tumors with which it has been confounded.

The diagnosis may readily be made from the history, shape of the tumor, and its position in the median line (Fig. 217), aided, where necessary, by catheterization, which is followed by the disappearance of the tumor. Wherever any question exists, and, in fact, to aid palpation of tumors of the lower half of the abdomen in general, the patient should be catheterized.

2. **Osteosarcomata.**—Sarcomata arising from the inner aspect of the os innominatum must be suspected, if the tumor is found in the iliac fossa, is fixed, hard, and gives the history of rapid growth.

3. **Neoplasms of Lymph-nodes.**—Tumors arising from the lymph-nodes lying along the pelvic brim are rare and are accompanied by evidences of a primary growth or by inflammatory symptoms. They may often be palpated through the rectum or vagina.

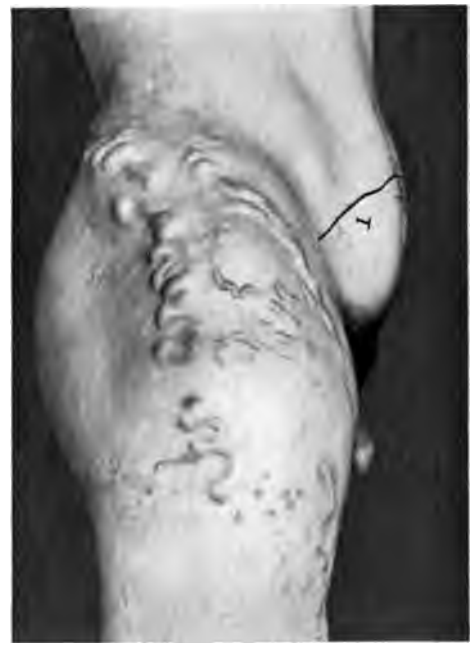


FIG. 237.—VIEW FROM RIGHT SIDE OF TUMOR OF ABDOMEN (*T*) DUE TO AN ANEURYSM OF THE EXTERNAL ILIAC ARTERY.

Note the prominent varicose veins over the region of the trochanter. This is the same case as shown in Fig. 238.

4. **Tumors arising from the pelvic viscera of the female** are the following:

1. Pregnant uterus.
2. Large uterine myomata which extend into the abdominal cavity.
3. Pedunculated uterine and ovarian tumors.
4. Large ovarian tumors.

The possibility of the presence of the first named condition must never be forgotten in the diagnosis of tumors of the lower half of the abdomen and the signs of pregnancy must be sought for.

Large uterine myomata are in general of round form and firm consistency. They may, however, be quite soft and give a sense of fluctuation. They can usually be moved with the body of the uterus and if submucous are accompanied by severe menstrual and intermenstrual hemorrhages. When interstitial, no symptoms are produced except those due to an enlarged uterus.

Pedunculated Ovarian and Uterine Tumors.—These may have such a long pedicle as to permit the tumor to be moved or palpated, as the case may be, from the pelvis to the costal arch, unless they are fixed by adhesions, under which circumstances it is almost impossible to recognize their nature before operation. If not thus fixed, bimanual examination will often reveal the pedicle and its relation to the pelvic viscera.

Larger Ovarian Tumors.—These, unless colossal, can be recognized by the fact that they rise out of the pelvis, and their pedicle can often be traced toward the uterus, especially by bimanual examination.

They cause contrasting physical signs to those of ascites unless accompanied by the latter. These signs are prominence and dullness over

FIG. 238.—LATERAL VIEW OF TUMOR OF ABDOMEN DUE TO ANEURYSM OF THE EXTERNAL ILIAC ARTERY CAUSING PROMINENCE IN RIGHT ILIAC REGION.
Note the extensive varicose veins along the outer aspect of the thigh.

the pubes and in the median regions, but tympany in the flanks (Fig. 219).

The diagnoses of the various smaller pelvic tumors arising from the uterus and adnexa are not considered here, as they are fully discussed in the special books on gynecology.

DISEASES OF THE PHARYNX AND ESOPHAGUS.

The chief lesions of the pharynx which are of general surgical interest are: (*a*) retropharyngeal abscess; (*b*) tumors of the tonsils; (*c*) nasopharyngeal polyps.

(*a*) Retropharyngeal abscesses may be acute or chronic in their course. The presence of such an accumulation must be suspected when

symptoms of dyspnea due to some obstruction high up in the respiratory tract are present. The finger inserted directly backward encounters a soft bulging along the posterior wall of the pharynx. Such abscesses may gravitate and present externally along the anterior border of the sterno-cleidomastoid.

(*b*) Tumors (neoplasms) of the tonsils are either carcinomata or sarcomata. The diagnosis may be made from the characteristic indurated ulcer in the former and the age (above fifty) in carcinoma and the rapid enlargement in sarcoma.

(*c*) Nasopharyngeal polyps belong to either the fibromata or fibro-sarcoma. They grow either from the nose into the pharynx or are primary at the base of the skull. The symptoms are those of gradually increasing nasal obstruction, accompanied by symptoms of pressure upon the adjacent parts.

STRICTURE OF THE ESOPHAGUS.

The esophagus extends from the level of the cricoid cartilage to the cardiac end of the stomach. The beginning is 15 cm., the termination 40 cm., from the teeth (Fig. 239). There are certain points where the esophagus is normally constricted, and these must be borne in mind when an examination with bougies for a suspected stricture is made. These narrow points are (Fig. 239):

1. At the beginning, opposite the cricoid or 15 cm. from the teeth.
2. Opposite the bifurcation of the trachea or 26 cm. from the teeth.
3. Where it penetrates the diaphragm or 37 cm. from the teeth.

Methods of Examination.—The most frequently employed method of examination for esophageal stricture is the use of graduated bulbous bougies passed in the manner shown in Fig. 240. Instead of the flexible bougie with or without an olive-shaped tip, one can use a gum-elastic stomach-tube. The patient should be seated on a low chair with head bent backward. Holding the patient's tongue down with the index-finger of the left hand, the bougie is passed directly back to the posterior wall of the pharynx, where the resistance prevents further progress in that direction. The bougie or gum-elastic stomach-tube is then directed downward, great care being employed to avoid perforating a carcinomatous area or a diverticulum. It is advisable to begin with a large size and reduce the caliber if it is impossible to pass the first one. The esophagoscope has been employed for the purpose of locating strictures by Gottstein and others, but it requires great dexterity, so that for general purposes we rely on the above two methods.

When a genuine resistance is met the bougie is withdrawn and the distance of the stenosis from the teeth is noted.

Other methods of locating strictures, such as auscultation posteriorly while the patient swallows water, are seldom employed and are not so

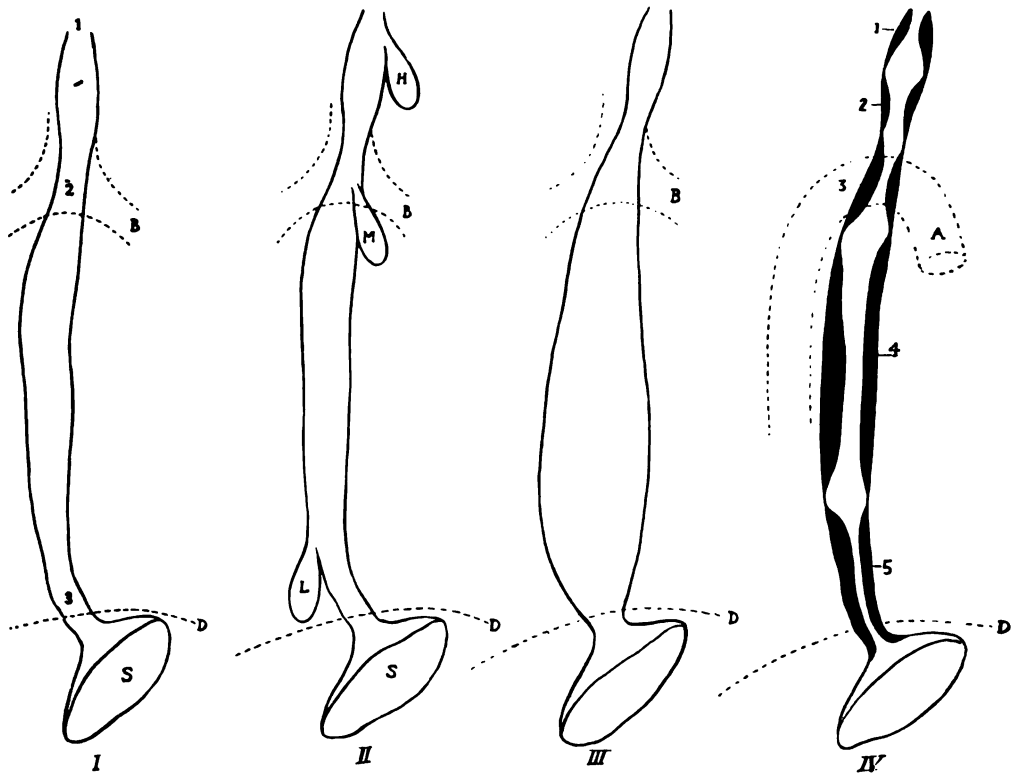


FIG. 230.—NORMAL AND PATHOLOGIC CONDITIONS OF THE ESOPHAGUS.

In all of the diagrams B represents the bifurcation of the trachea into the two main bronchi; D is the diaphragm, and S, cardiac end of the stomach. I, Normal esophagus: 1, Showing the normal point of narrowing at its junction with the pharynx; 2, opposite the bifurcation of the bronchi; 3, at the diaphragm. II, Location of most frequent diverticula of the esophagus: H, Cervical form of pulsion or pressure diverticulum: M, ocation of traction diverticulum opposite bifurcation of trachea; L, location of diverticulum close to cardiac end of stomach. III. Sacculated condition of esophagus or so-called idiopathic dilatation as the result of spasm of the cardiac end of the esophagus (cardiospasm). IV, Diagrammatic representation of most frequent seats of stenosis or stricture of the esophagus: A, Arch of aorta; 1, stenosis as a result of carcinoma of the lower end of pharynx and beginning of esophagus; 2, stenosis as a result of pressure from tumors of the neck; 3, stenosis as a result of aneurysm of the arch of the aorta; 4, stenosis as a result of caustic or lye strictures; these latter may extend along the entire length of the esophagus; 5, stenosis as a result of carcinoma of the lower end of the esophagus and cardiac end of stomach.

reliable as the passage of flexible spiral metal or hard-rubber bougies. In every case it is advisable, in addition to instrumental examination, to insert the index-finger into the pharynx, since one may at times be able to palpate a malignant growth at the beginning of the esophagus. An at-

tempt should be made to recognize not only the location but also the nature of the stricture if one exists.

Within recent years bismuth and similar substances which cast a shadow in a skiagraph have been employed to locate strictures of the esophagus, and also in cases of diverticula and dilatation. The patient is given about one ounce of bismuth subnitrate mixed with bread or potato and instructed to swallow it. The substance lodges above the point of stenosis, as shown in Fig. 241, causing a distinct shadow in cases of dilatation. One gets a spindle-shaped shadow corresponding to the extent of the dilatation. Another method, to be referred to below,

FIG. 240.—METHOD OF PASSING ESOPHAGEAL BOUGIES IN ORDER TO DETERMINE THE LEVEL OF A STRICTURE.

Note how the patient's head is held slightly backward, the left hand being placed upon the forehead, while the right hand grasps the bougie in a manner similar to that of holding a penholder, no force being used.

is also employed, consisting in having the patient swallow a bag filled with shot, which gives rise to a shadow at the point of stenosis or within the sac of the diverticulum.

Diagnosis.—The diagnosis of esophageal stricture in general may be made from the following:

1. History of difficulty in swallowing accompanied by the regurgitation of food or mucus, often mixed with blood.

2. History of some etiologic factor mentioned below under the head of cicatricial or extra-esophageal or malignant causes. The exclusion of a neurotic cause of the stenosis must always be made.

3. The results of the local examination with the bougies, stomach-tubes, esophagoscope, or an *x*-ray after bismuth has been swallowed.

The diagnosis of the cause of the stricture may be made by excluding the following in their order:

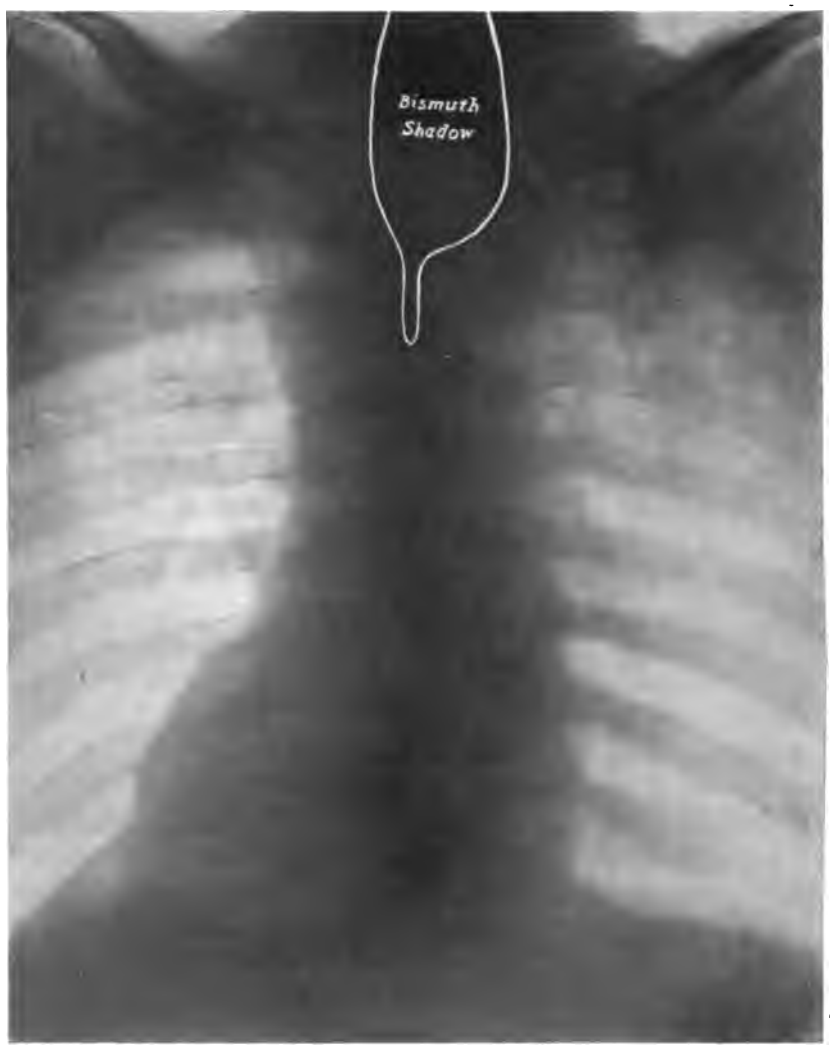


FIG. 241.—X-RAY OF A CASE OF STRICTURE OF THE ESOPHAGUS OPPOSITE THE BIFURCATION OF THE TRACHEA. The outlines of the bismuth shadow have been traced in white.

1. *Cicatricial Strictures.*—These give the history of having swallowed caustic liquids or having had some disease which could produce esophageal ulcerations, such as syphilis or typhoid fever. The bougie

meets a firm resistance which responds readily to treatment by graduated bougies.

2. *Strictures due to Pressure from External Causes.*—This group includes pressure upon the esophagus from aneurysm of the arch of the aorta, enlarged cervical or retrosternal goiter, especially when malignant, enlarged cervical and bronchial glands, tumors of the neck or mediastinal tissues, rarely pericardial effusions, and lastly by esophageal diverticula.

It is unnecessary to consider the diagnosis of these various extra-esophageal causes of strictures here, as they are discussed under the respective headings.

3. *Carcinomatous or Malignant Strictures.*—This is by far the commonest cause of stricture of the esophagus in patients above forty, and especially after the age of fifty years.

The dysphagia common to all strictures appears in carcinoma, gradually accompanied by progressive emaciation and loss of strength. The other symptoms vary according to the situation of the carcinoma.

(*a*) If at the beginning of the esophagus (Fig. 239) there is immediate regurgitation of the food and early enlargement of the cervical lymph-nodes. In one case recently seen the patient consulted the writer in regard to the tumor of the neck before the dysphagia had become sufficiently marked to attract his attention.

(*b*) If the cancer is situated at the level of the bifurcation of the trachea, hoarseness and aphonia are marked.

(*c*) If situated close to the cardiac end the regurgitation of food occurs much later, often ten to fifteen minutes after being swallowed.

The bougie is arrested at the beginning of the carcinoma and *no force should be employed in passing through it.* A sudden improvement in the stenosis symptoms, points to ulceration of the cancer. Late sequelæ of malignant stricture are perforations into the pleural cavity or mediastinum.

4. *Spasmodic Stricture.*—This fourth variety of stricture is comparatively rare and can usually be distinguished from the cicatricial, extra-esophageal, and malignant forms by the history and the physical examination. The spasmodic strictures occur in nervous hysterical women, but may occur in elderly men, and are often associated with hypochondriasis or true hysteria. The bougie is often temporarily arrested at the point of spasm, but by waiting a short time it can be passed through the stricture readily, especially under anesthesia.

DIVERTICULA OF THE ESOPHAGUS.

There are two varieties:

1. Traction diverticula situated on the anterior wall opposite the bifurcation of the trachea. They are caused by cicatrices resulting from bronchial lymph-node or pleuropericardial inflammation, drawing the anterior wall out.

This form cannot be diagnosed unless, as rarely occurs, food collects within the sac so that a pressure diverticulum is formed.

2. Pressure diverticula occur in three places:

(*a*) In the pharynx, causing at times a tumor in the neck, referred to on page 189, which can be emptied when filled with food. This is the most frequent form.

(*b*) At the bifurcation of the trachea developing from a traction diverticulum.

(*c*) Just above the diaphragm.

The diagnosis of a diverticulum of the pharynx may be readily made if there is a history of a tumor of the neck, most often on the left side, which develops during eating, can be emptied by pressure, and is accompanied by the regurgitation of food. A bougie is arrested at the cricoid and may be passed into the sac and freely moved about, so that the tip can be felt in the neck. If situated lower down, other means of diagnosis are employed, and the condition must be differentiated from stricture and dilatation of the esophagus, because in all three the symptoms of regurgitation of food are present.

The methods of diagnosis at present employed to differentiate these three varieties of pressure diverticulum are:

1. The use of bismuth or similar shadow-producing substances and a skiagraph. If the patient is allowed to swallow a bag of bird-shot or a mixture of bismuth and bread, it often enters the diverticulum and gives rise to a distinct shadow.

2. A bougie enters the opening of the diverticulum, if the latter is full, and is arrested there, but meets with no obstruction and passes into the stomach, if the sac is empty. This intermittent arrest of the bougie is characteristic of deep-seated diverticula.

One tube can at times be passed into the diverticulum and a second alongside of it into the stomach. If different colored fluids are poured into them separately, they will return unmixed.

3. The esophagoscope often shows the opening of the diverticulum, but, as stated above, its employment requires considerable skill and practice. A deep-seated diverticulum is distinguished from a stricture

by the fact that the arrest of the bougie is intermittent in the former and constant in the latter. (See method 1, above.) It may be differentiated from a diffuse dilatation either by the skiagraph or the Rumpel test, which is as follows:

A tube with lateral openings is passed into the stomach, while a second one is passed into the diverticulum. If there is dilatation, colored fluid poured into the tube at the point of enlargement will flow through the lateral openings into the stomach. If a diverticulum is present nothing will flow out of the tube in the stomach, while from the tube in the diverticulum all the fluid poured in will be recovered.

IDIOPATHIC DILATATION OF THE ESOPHAGUS.

This frequently follows a spasm of the lower end of the esophagus. The lumen may become enormously dilated, so that when a bougie is passed it meets with no obstruction but has a very wide range of motion. A skiagraph taken after the ingestion of bismuth often shows a spindle-like shadow. The esophagus will hold 500 c.c. of fluid instead of 100 c.c. of fluid. In the majority of cases the patients suffer from difficulty in swallowing, and from regurgitation of food soon after eating or several hours later. There is great fetor and a feeling of oppression in the thorax which is only relieved by vomiting. The regurgitated food contains no HCl, but an excess of lactic acid.

FOREIGN BODIES IN THE ESOPHAGUS.

These may be divided into those which are rough and those which are smooth. The former cause both obstruction and injury to the wall of the esophagus, while the latter only cause obstruction. If situated high up near the opening of the glottis, foreign bodies, like chunks of meat, may cause asphyxia. If they are smaller they give rise to attacks of cyanosis and suffocation. If the foreign body is sharp it causes pain which is often referred to the sternum.

The diagnosis may be made from (*a*) the history, in the majority of cases; (*b*) examination by the various methods to be mentioned; and (*c*) the symptoms of dysphagia, pain, and appearance of periesophageal abscesses due to perforation of the wall and infection of the surrounding connective tissue.

The **methods of examination** are (*a*) the passage of an olive-tipped bougie, which is arrested where the foreign body is lodged unless its convex surface lies in the concavity of the anterior wall.

(*b*) Esophagoscopy.

(*c*) A skiagraph is very valuable if the foreign body is a metallic one.

(*d*) The finger should be inserted into the beginning of the esophagus and the laryngeal mirror used.

In the preceding sections an effort has been made to group affections as they present themselves when we are called to the bedside of a patient to make a diagnosis.

As stated in the preface, it was thought by the author that such a grouping more nearly meets with clinical conditions than would one in which the injuries or diseases of each viscus were discussed separately.

It is impossible, however, to consider every condition under the heads of Traumatisms, Acute Affections, and Tumors of the Abdominal

FIG. 242.—PYLORIC STRICTURE. (kind permission of Dr. W. J. Mayo).

Viscera, so that it will now be necessary to take up the remaining diseases of the various abdominal viscera which are of interest from a surgical standpoint.

SURGICAL DISEASES OF THE STOMACH.

GASTROPTOSIS.

This may exist independently or be associated with a general splanchnoptosis. Normally the stomach extends to a point two inches above the umbilicus. When the ligaments supporting the stomach are lengthened, the viscus slips below its normal position, so that in extreme cases the greater curvature may be at the level of the umbilicus. The symptoms produced by this downward displacement are those of motor atony and dilatation, such as a feeling of fullness after eating and flatulency. Vom-

iting may occur, and at times acute dilatation takes place, causing dyspnea, rapid pulse, etc., as the result of displacement of the heart (Fig. 558). The vomitus contains at times food which was ingested twenty-four to forty-eight hours previously. Upon succussion, a splashing sound can be elicited over the stomach in these cases, and the position of the viscus can usually be distinctly outlined by percussion.

Pyloric Stenosis.

Stenosis of the pylorus may be either congenital or acquired. The latter is almost always the result of a gastric ulcer or carcinoma, so that the diagnosis will be considered on pages 381 and 384.

The congenital form of pyloric stenosis is not as rare as formerly thought. It is necessary to make a clear distinction between cases of congenital pyloric spasm occurring in infants and cases of true congenital hypertrophic pyloric stenosis. In the former there is only a slight muscular hypertrophy at the pylorus, while in the latter there is such a marked increase in muscular and connective-tissue element at the pylorus as to give rise to a mass resembling a neoplasm and reducing the size of the pyloric orifice to such an extent as to produce almost complete obstruction. In true congenital stenosis the diagnosis may be made from the history, combined with inspection and palpation of the pyloric region. The symptoms begin within the first few weeks after birth. The infant is unable to retain any food, vomiting soon after it takes any nourishment. This is accompanied by marked constipation and rapid emaciation. Inspection of the epigastrium will reveal a prominence due to a dilated stomach with visible peristaltic waves from left to right. On palpation one can feel the typical sausage-shaped firm tumor in the region of the pylorus. This condition must always be borne in mind when vomiting occurs repeatedly in very young infants.

Dilatation of the Stomach in Adults.

This is most often the result:

(*a*) Of stricture or adhesions following the healing of a round ulcer.

(*b*) Of malignant disease of the pylorus.

(*c*) Of gastric atony.

The diagnosis of gastric dilatation, whether congenital or acquired, is readily made from the following:

Vomiting is the most prominent symptom. At varying intervals, ordinarily every two or three days, an enormous quantity of liquid mixed with undigested food, and of an offensive odor is brought up. In the intervals there is complaint of oppression after eating, eructations of [redacted]. Tetany may occur as an early symptom.

When the stomach is full one can easily demonstrate a splashing sound on succussion. The outlines of the distended organ are often visible and peristaltic waves can be seen passing across it toward the pylorus. When the stomach is inflated with air the outlines become very plain. In *gastroptosis* both the lesser and greater curvatures are at a lower level, while in dilatation the lesser remains almost normal, although the greater may even be as low as the symphysis pubis. A history of many years' duration, preceded by severe pain after eating and either melena or hematemesis, speaks for ulcer as the cause of the obstruction. Rapid emaciation, absence of HCl in the vomit, palpation of a tumor, speak for malignancy. Adhesions rarely cause a marked degree of dilatation.

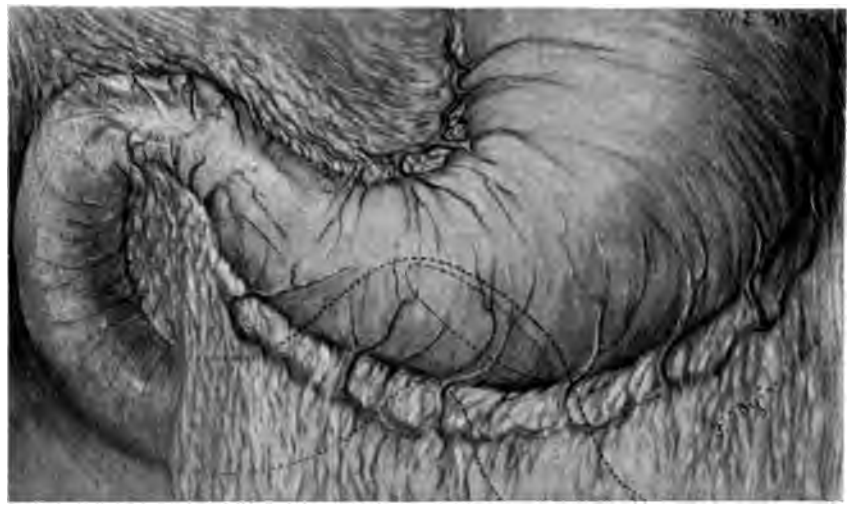


FIG. 243.—ULCER OF THE DUODENUM (kind permission of Dr. W. J. Mayo).

GASTRIC ULCER.

Ulcers of the stomach and duodenum can be divided surgically into two classes, according to W. J. Mayo.[1] First, the indurated or calloused ulcer which can be seen and felt from the outside of the stomach. Second, the nonindurated mucous ulcer, which cannot be identified from the outside of the stomach or duodenal wall. The site of the nonindurated mucous ulcer does not betray its presence by a thickening or other sign. This latter class usually involves only the mucosa, and belongs to the class spoken of as acute round ulcers. These frequently occur in chlorotic young women and give rise to severe hemorrhage or perforation. Duod-

[1] "Annals of Surgery," June, 1907.

enal ulcers frequently coexist with gastric ulcers, and are found as often as the latter. The acute gastric ulcer is round or oval (Fig. 244) and has a punched-out appearance, while the chronic indurated ulcer is irregular in shape.

Diagnosis of Gastric Ulcer.—In many cases the presence of an ulcer of either the stomach or duodenum is not suspected until the patient is seen on account of one of the complications, such as hemorrhage, perforation, etc. (see page 382). These latent ulcers form about 20 per cent. of the cases (Savariaud). In the remaining 80 per cent. the symptoms are sufficiently marked to enable a diagnosis to be made in the majority of cases. These symptoms are:

Pain.—This is a prominent sign in many cases, but may be absent. The pain is usually well localized in the epigastrium and often radiates to the left shoulder. It is increased by taking food. The majority of ulcers occur in the pyloric region, and pain is felt in these from one to three hours after taking food. If the ulcer lies on the lesser curvature or near the cardia, the pain is felt almost immediately after eating. In duodenal ulcer the pain is at its height from two to five hours after taking food, and seldom radiates beyond the epigastrium. It entirely disappears or is quieted for a time by food.

Vomiting and Gas.—This and various signs of indigestion are frequently seen in cases of gastric ulcer. Vomiting, when present, generally occurs from one to four hours after eating. When pyloric stenosis is present as the result of a gastric ulcer or as the result of a pyloric spasm, there is great discomfort from gas, and attacks of acute dilatation may occur, which is not relieved until the gas is belched up.

Hemorrhage.—Hemorrhage occurs in 50 to 80 per cent. of gastric ulcers (Mayo-Robson). It may occur as an acute gastrorrhagia in young chlorotic women from the acute round ulcers described on page 380. These are often fatal. In the so-called mucous ulcer of more chronic type and in the indurated ulcer (see Fig. 242) bleeding may occur in one of three ways: (1) Quite rarely as an acute fulminating hemorrhage, either vomited or passed through the bowels. (2) As severe bleeding, which, although arrested temporarily, tends to recur in a few hours or a few days, and which, after one or more relapses, may prove fatal. (3) Slight, frequently recurring hemorrhages, tinging the vomit or only found in the feces upon making the guaiac or benzidin tests. (See books on clinical diagnosis for details of these tests). Of these two tests the guaiac test is the best, since the benzidin test is very delicate, and is of value only when the result is a negative one.

Stomach Contents.—The presence of free HCl, especially if in excess, in the vomit or in the gastric lavage after a test meal, is confirmatory evidence of ulcer, whereas the absence of free HCl and the presence of lactic acid are presumptive evidence in favor of malignant disease.

Diagnosis of the Complications of Gastric and Duodenal Ulcer.—1. *Perforation* was referred to in the section on acute abdominal affections, page 306. It may be acute, subacute, or chronic. The two former are described on pages 306 and 308. The chronic form will be considered under perigastric abscess.

FIG. 244.—MULTIPLE ULCERS OF POSTERIOR WALL OF STOMACH (A. D. Kohn).

P, Pylorus. By following the illustration downward from this letter, one can note the rather sharp demarcation between the gastric mucous membrane, on which the ulcers are situated, and the duodenum, shown at D. 1, 2, 3, and 4 are typical round ulcers showing great variation in size, situated on the posterior wall of the stomach.

2. *Perigastric Abscess including Subphrenic Abscess due to Perforation.*—The diagnosis is dependent on the history of the ulcer, as given above, followed by symptoms of a localizd peritonitis, usually of a left subphrenic abscess. There is a history of chronic ulcer followed by irregular fever, tenderness over the left upper quadrant of the abdomen combined with physical signs over the lower part of the left side of the chest, as in empyema. Occasionally induration and tenderness are present in the epigastrium. If a retroperitoneal abscess form, the pus

may burrow toward the lumbar region and cause fluctuation here. Gas is more frequently present in left than in right subphrenic abscess, so that above the dullness there is tympany. Unless there is an accompanying pleuritic effusion, breath sounds are heard above the upper level of dullness and there is respiratory mobility. The three zones of normal lung resonance, tympany and dullness are well shown in Fig. 190.

3. *Hour-glass Stomach.*—This most often follows cicatrization of an ulcer dividing the stomach into two halves. The diagnosis may be made from the following signs and tests:

First, when fluid is introduced into the stomach it seems to disappear altogether, and is not returned through the tube. Second, when the stomach is washed out, until the fluid returns clear, there is a sudden, unlooked-for gush of foul or often putrid fluid. Third, on distending the stomach with carbon dioxid, the bubbling and gushing of fluid through a narrow chink can be heard with a stethoscope. Fourth, there may be a distinct visible or palpable sulcus separating two dilated cavities.

4. *Perigastric Adhesions.*—These may be recognized by pain, increased by exertion or after eating. In some cases there is more or less dilatation with signs of retention of food, such as distress after eating, gas formation, and vomiting. There is also slight tenderness over the epigastrium and the occasional presence of a palpable tumor. There is often a history of gastric ulcer (perigastric adhesions in 40 per cent. of the cases of gastric ulcer) or of gallstones. The tumor may resemble that of cancer, but is never accompanied by the progressive emaciation of the latter condition. The course is very chronic and is frequently accompanied by evidences of biliary stasis and absorption.

Carcinoma of the Stomach.

The fact that carcinoma of the stomach develops in an old ulcer is being generally recognized. It is also an accepted fact that about 5 per cent. of all of the cases of gastric cancer run a latent course, so that their discovery is an accidental one. This is, of course, especially the case in cancers which develop in either the anterior or posterior wall and do not obstruct either the cardiac or pyloric orifices. In cancer of the cardiac end of the stomach the symptoms are essentially those of an esophageal stenosis, the most marked symptom being a dysphagia. The majority of cases of carcinoma of the stomach occur within three inches of the pylorus. Moynihan believes that there are two classes: (1) Pyloric growths which begin in the pylorus or within a very short distance of it

and at the earliest stage begin to cause constriction there. (2) The prepyloric growths, which almost always begin at the same point on the lesser curvature, 1½ to 2½ inches from the pylorus. The latter form spreads along the curvature in both directions, but chiefly away from the pylorus, involving the latter relatively late. In the pyloric form the symptoms are, from the first, of an obstructive character, viz., those of gastric dilatation (page 379) associated with vomiting. In the prepyloric form the symptoms are less definite, such as loss of appetite, intolerance of solid food, uneasiness after meals, occasional vomiting of a turbid watery fluid in small quantities, and loss of weight. The majority of cases give a clear history of chronic gastric ulcer upon which the carcinoma is engrafted, as in the case shown in Fig. 245. The diagnosis can usually be made from the following data:

	Gastric Ulcer.	Duodenal Ulcer.	Gallstones.
Pain.....	Is usually present. It is referred to the epigastric region and radiates to the left shoulder. It is increased by the ingestion of food. If the ulcer is along lesser curvature or near cardia, it occurs half an hour after eating. If the ulcer is pyloric, it occurs one to three hours after eating.	The attacks of pain run in periods or cycles lasting a few days or several months. It is burning or gnawing in character, and is most marked from two to five hours after eating. It disappears or is quieted for a time by food, drinks, alkalies, vomiting, or irrigation.	The pain is sharp and lancinating. The attacks of pain have no relation to the ingestion of food. They are sudden in onset and disappear as rapidly as they begin. The pain is first felt in the right hypochondrium and radiates to the right shoulder. It may be accompanied by chills, fever, and sweats.
Tenderness .	Well marked in the epigastric region. May be diffuse or quite sharply localized.	Often present to right of median line. Quite marked if any localized peritonitis present.	Tenderness and muscular rigidity in right hypochondrium during or just after attacks.
Vomiting and gas.....	Vomiting a prominent symptom in many cases. Occurs one to four hours after eating. Attacks of distress from gas similar to those in duodenal ulcer.	Nausea and eructation present in early stage. Vomiting commonly found in later cases. Begins two to four hours after eating or it occurs once daily or every two or three days. Gas formation typical. Occurs two to five hours after eating, relieved by food, alkalies, etc.	Vomiting after initial pain and may give relief. Intense nausea produces severe retching followed by greenish bitter fluid and mucus.

	Gastric Ulcer.	Duodenal Ulcer.	Gallstones.
Hemorrhage	Occurs in greater or lesser degree in 50 to 80 per cent. of cases. In acute round ulcer (young girls) have severe fatal hematemesis. In mucous or chronic indurated have either severe fatal hematemesis or recurrent slight amounts in vomitus, less often in stool.	Often present, either microscopically (tests for occult blood) in feces or have sudden fainting and collapse with large tarry stools (melena). Blood in small amounts more often found in feces than in gastric ulcer.	Rare, and may then be only accidental.
Stomach contents.....	Acidity runs above normal. Blood may be found in traces or larger quantities.	Same as gastric ulcer. Blood seldom found except in feces.	Contents normal unless adhesions present.
Loss of nutrition.....	Only slight, unless carcinoma developing on ulcer (see page 386).	Loss of nutrition in later cases only.	Rarely affected in early stages; later only if chronic jaundice, pancreatic infection, or cancer.
Age and sex..	Occurs with about equal frequency in men and women.	More frequent in men above middle age.	More frequent in women.

The presence of this condition is diagnosed if, in a patient above the age of forty, with or without the history of ulcer, signs of digestive disturbances appear accompanied by pain, anemia, loss of weight, and vomiting.

(*a*) The history of steady, progressive loss of weight, without other assignable cause.

(*b*) The presence of a secondary anemia, both red corpuscles and hemoglobin being reduced. In some cases of cancer of the stomach the clinical picture may be that of a pernicious anemia.

(*c*) Pain. This is an early and important symptom. At first only a heaviness after eating is noticed, but later it is of a dull, gnawing character referred to the epigastrium. Pain may be entirely absent, but in about 80 to 90 per cent. of the cases pain is a prominent symptom.

(*d*) Vomiting occurs in about 85 per cent. of the cases. It is usually a later symptom than pain. If the stomach is dilated, the vomit may be large in quantity every second or third day. If the stomach is small, the vomiting occurs oftener and in smaller quantities. When the tumor is

near the pylorus, it occurs from one to two hours after the taking of food. At first it is infrequent, but later is almost constantly present.

(*e*) Hemorrhage. This rarely occurs as bright red blood, but most frequently in smaller quantities, giving the vomitus the typical "coffee-ground" appearance in the later stages.

(*f*) Stomach contents. An analysis of the stomach contents after a test meal has been given should be made on several occasions at short intervals in order to draw accurate conclusions.

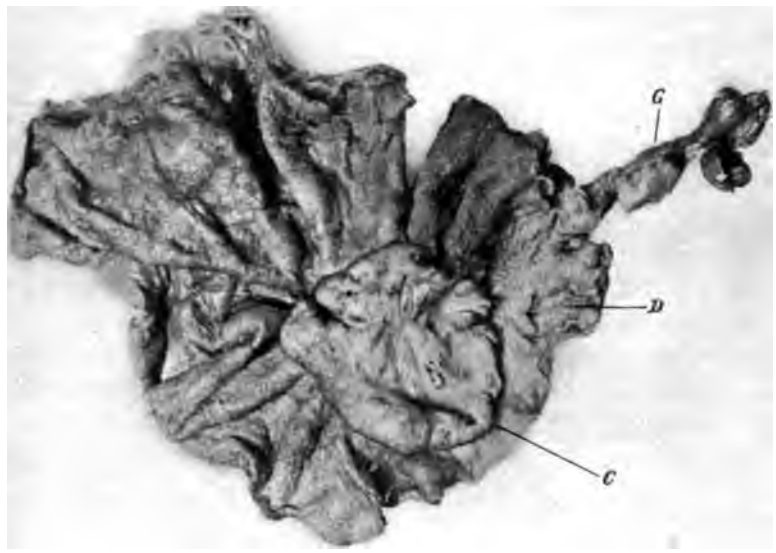


FIG. 245.—CARCINOMA OF STOMACH DEVELOPING UPON ROUND ULCER (A. D. Kohn).

This is the primary tumor whose metastases are seen in the liver in Fig. 224. *C*, Observe the sharp demarcation between the carcinoma and the surrounding normal mucous membrane of the stomach. *D*, Mucous membrane of duodenum. Observe the proximity of the carcinoma to the pylorus. *G*, Lymph-nodes along gastrohepatic omentum.

The constant absence, or great reduction of hydrochloric acid and the presence of lactic acid are strongly indicative of cancer. Unfortunately, these data are often so late in their appearance as to be of little value unless present quite early. Occult or visible blood in the stomach contents or stools is of great value in the diagnosis.

On the other hand, carcinoma may exist although hydrochloric acid is present. The latter is the condition frequently found in cases of carcinoma developing upon a round ulcer (Fig. 245).

The presence of the Oppler-Boas bacillus is of slight value, but the detection of lactic acid in the stomach contents after a Boas test meal is

of greater value. The constant presence of blood intimately mixed with the gastric contents is also of great importance, especially if vomited alone; as hydrochloric acid is absent in cases of chronic gastritis or atrophy of the mucosa, the value of the presence of blood is apparent.

(*g*) Tumor. This is the most important symptom, but, like the changes in the stomach contents, is often only present at a late stage, and one should never wait for the detection of a tumor before making a diagnosis. The surface is usually smooth.

Unless adhesions exist a tumor of the stomach is freely movable (Fig. 220) and is best felt when the stomach is empty. Usually the tumor is located in the epigastric or umbilical regions, but in gastroptosis may be in the right iliac region (Fig. 222). The presence of an ascites may render the palpation of a tumor impossible until the fluid is aspirated, and this should, of course, be done.

Duodenal Ulcer.[1]

Ulcer of the duodenum was formerly believed to be quite a rare affection, but the recent statistics of Mayo, Moynihan, and Mayo Robson show that it occurs almost as frequently as gastric ulcer. The diagnosis of the perforation of duodenal ulcer has been discussed on page 381, under acute abdominal affections. The onset of pain in perforation of duodenal ulcer is very sudden and the pain itself quite severe. There is always considerable shock accompanying the sudden onset. The upper abdomen is rigid and very tender. The pain is at first, in some cases, felt above the umbilicus to the right of the median line. In many cases (see page 384) the pain is referred to the appendix. Later the pain and muscular rigidity become general, accompanied by rapid pulse, vomiting, gradually increasing tympany—in other words, the clinical signs of a spreading peritonitis (see page 275). In many of these cases careful inquiry will elicit the history of the symptoms of duodenal ulcer next to be enumerated.

The majority of duodenal ulcers occur in males above middle age, and are of the indurated type described on page 383 as occurring in gastric ulcer. The thinner wall of the duodenum permits of easier recognition of this indurated ulcer than is the case in the thicker walls of the stomach. Ulcer of the duodenum is nearly as common, according to Dr. W. J. Mayo, as gastric ulcer. The diagnosis of duodenal ulcer can usually be made by a consideration of the following symptoms:

[1] The author is indebted to the excellent articles of Drs. W. J. Mayo and Christopher Graham for many valuable points in the preparation of this section and the table on page 384.

Pain and Tenderness.—The pain of a duodenal ulcer is usually felt about two to five hours after eating, and is limited to the epigastrium, being quite often localized to the right of the median line. It disappears or improves after eating, drinking, use of alkalies, vomiting, or gastric lavage. The pain is of a burning or gnawing character, and seems to appear in cycles lasting from a few days to several months. Tenderness is often present to the right of the median line, and is quite marked if any localized peritonitis be present.

Vomiting and Gas.—Nausea and eructation are present in the early stages oftener than vomiting. The latter is quite commonly present in the later period. It begins from two to four hours after food is taken, or it occurs once daily or every second or third day. Gas formation is very typical of duodenal ulcer, according to C. Graham.[1] It occurs from two to five hours after eating and is relieved by drinks, food, alkalies or vomiting.

Hemorrhage.—This is not infrequently present. It may only be latent, and can then be detected by the examination of the feces for blood by the benzidin or guaiac tests. In some cases severe hemorrhages occur, the blood being passed in the stool as dark, tarry masses. The onset of such severe bleeding in duodenal ulcer can be diagnosed by the occurrence of sudden collapse, accompanied by pallor and other signs of internal hemorrhage (thirst, rapid pulse, restlessness), followed later by black, tarry stools.

Stomach Contents.—The analysis will reveal the same findings as in gastric ulcer, viz., a degree of acidity which is considerably above normal. Blood may be found in traces.

Complications.—The complications of duodenal ulcer are quite similar to those of gastric ulcer, viz., stenosis, hemorrhage, perforation, and the formation of a periduodenal abscess or of periduodenal adhesions. Of these, perforation has been considered on pages 306 and 307. Stenosis is very rare. The occurrence of abscess formation can be suspected when pain, temperature, tenderness, rigidity, occur in a patient who gives the history of a duodenal ulcer.

GALLSTONES (CHOLELITHIASIS).

Many cases of cholelithiasis are either not recognized during life or they are found as an accessory condition in operations for other intra-abdominal lesions.

Cases in which a diagnosis is possible, occur clinically in different forms, as follows:

[1] "Jour. Amer. Med. Assoc.," Feb. 9, 1907.

1. Those seen during an attack of biliary colic or of empyema of the gallbladder (see page 305).

2. Those showing evidences of a complete occlusion of the cystic duct by a calculus (see Fig. 246).

3. Symptoms of common duct calculi with or without accompanying infection.

4. Cases seen in the interval between active symptoms pointing to the bile-passages.

3. **Common Duct Stones.**—A stone passing through the common duct may give rise to colic which cannot be distinguished, during the attack, from that due to the passage of a calculus through the cystic duct or from an attack of acute cholecystitis with calculi. The most frequent location for common duct calculi is near the ampulla. The diagnosis must be made between one of two forms, according to whether the lumen is completely or incompletely occluded.

(*a*) Those causing complete obstruction. These are rare and may be recognized by the fact that the jaundice is deep and constant and there are no evidences of intrahepatic infection, as in the next group. They must be differentiated from new-growths pressing on the common duct by the absence of emaciation, and of symptoms indicative of cancer of the pancreas (page 346) or of the pylorus (page 383).

(*b*) Those causing incomplete obstruction due to a ball-valve action of the calculus. This is the more frequent form and is often accompanied by attacks of pain and chills at irregular intervals followed by high fever and a sweat as the result of a complicating cholangitis. Jaundice becomes marked and the liver may be enlarged and tender. In a late stage the gallbladder itself is contracted in the majority of cases. A ball-valve-like common duct stone may, however, occur without infection of sufficient intensity to cause symptoms. The diagnosis may then be made from the history of previous attacks of biliary colic and by variations in the intensity of the jaundice.

Differential Diagnosis.—These attacks of rigors, etc., so closely resemble those of malaria that a mistake in diagnosis has often been made. *Malarial paroxysms* occur with more regularity and are less frequently accompanied by jaundice, which, when present, is not deep. Nor is pain over the hypochondrium present, and unless quinin has been given, plasmodia can be found. There is also no leukocytosis in malaria, as a rule, and the spleen is enlarged. Exceptionally plasmodia are not found until quinin has been given.

The presence of jaundice between the chills, and of clay-colored stools, should always direct attention to the possibility of gallstones, for which the stools must be searched.

The diagnosis of *suppurative cholangitis* has already been referred to (page 272). The septic intoxication is more marked, the fever is of a more continuous type, the liver is enlarged and tender, and recovery does not occur.

4. **Diagnosis During the Interval.**—It is this class of cases in which the recognition of the condition is often most difficult, for one has

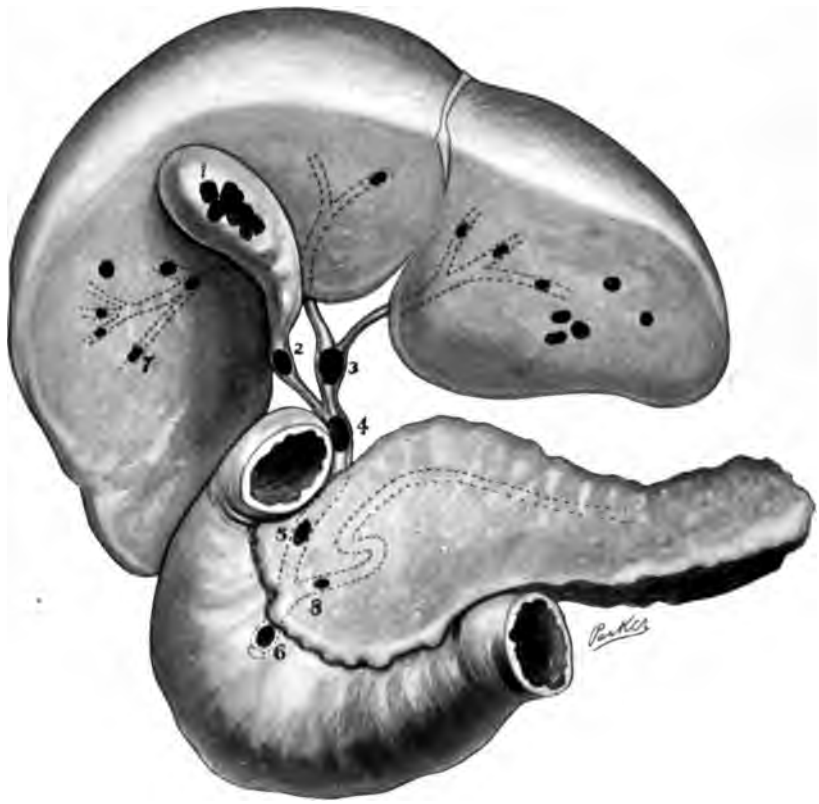


FIG. 246.—DIAGRAMMATIC SKETCH OF VARIOUS LOCATIONS OF GALLSTONES AND OF PANCREATIC CALCULI.

The liver has been turned upward in order to show the gallbladder. 1, Calculi in the gallbladder; 2, calculus in cystic duct; 3, calculus in hepatic duct; 4, calculus in supraduodenal portion of common duct; 5, calculus in retropancreatic portion of common duct; 6, calculus in ampulla of Vater; 7, calculi in intrahepatic bile-ducts; 8, pancreatic calculus in duct of Wirsung.

only the history and the results of the physical examination upon which to make a diagnosis.

History.—This is of the greatest importance, since many cases treated for years as gastralgia, indigestion, or intestinal colic, or even gastric ulcer, are found to be cases of gallstones.

The history should be directed toward the following points:

1. Has pain been present at any time? If so, one should secure a detailed description of the attacks and compare it with those of typical biliary colic.

Such paroxysms of pain are less frequently observed than is a dull aching pain referred to the gallbladder. This dull pain is increased by taking food, but is relieved by vomiting or by pressure over the gallbladder.

The biliary colic pain is acute in its onset, very severe, and disappears suddenly, while the dull pain above referred to is more or less continuous.

FIG. 247.—METHOD OF EXAMINATION TO ELICIT TENDERNESS OF GALLBLADDER (Moynihan).

Radiation to the shoulders occurs in both of these varieties of gallstone pain.

2. What alimentary symptoms have accompanied the pain? In the majority of cases there is a history of nausea and vomiting, accompanying the more severe variety of pain, or there is a history of long-continued digestive disturbances with dull pain over the gallbladder. **Jaundice** occurs so rarely in gallstones that its absence in the history must not permit one to think of excluding gallstones. This is especially true of stones in the gallbladder and cystic duct. Jaundice, if of slight degree, is difficult to detect. A good plan is to look at the roof of the

mouth at the back of the hard palate, where it is often visible, if nowhere else. It is also important to inquire in regard to the presence or absence of bile in the stools. The jaundice due to carcinoma of the head of the pancreas or to a calculus completely obstructing the common duct is persistent and progressive.

3. Have fever, chills, and sweats been present at any time? Irregular paroxysms of these three symptoms, especially if accompanied by jaundice which varies greatly in degree, speak for common duct stone. Continued fever with but slight remissions indicates an empyema of the gallbladder.

Physical Examination.—*Palpation of the Gallbladder Region.*—One can often detect hypersensitiveness of the gallbladder by pressing the fingers down upon the gallbladder as shown in Fig. 218 or by the method described by Moynihan and shown in Fig. 247. In the latter procedure, while sitting to the right of the patient, the left hand is laid over the right side of the patient's chest so that the thumb lies along the costal arch. As a deep breath is taken the thumb is pressed upward toward the under surface of the liver. In addition to the hypersensitiveness there is frequently rigidity of the upper end of the right rectus.

Diagnosis of the Location of Calculi if Arrested Temporarily or Permanently.—*Stones in the Gallbladder.*—These either cause no symptoms or they are those of an acute or a chronic cholecystitis. The diagnosis of the former is taken up on page 268. That of the latter is made from the presence of the dull, localized pain just described above, and digestive disturbances.

Stones in the Cystic Duct.—These cannot be distinguished from those of the gallbladder unless a tumor is palpable which can be recognized as due to a hydrops of the gallbladder (page 339), and this is not frequent. During the passage of a stone from the gallbladder into and through the cystic duct the symptoms are, for both, those of biliary colic.

Stones in the Common Duct.—Pain accompanied by distinct rigors, irregular fever, jaundice which varies in degree, and emaciation are characteristic of these calculi.

Stones in the hepatic duct or intrahepatic bile-passages cannot be recognized as such clinically.

APPENDICITIS (CHRONIC).

The diagnosis of acute appendicitis and its differentiation from other abdominal affections has been discussed on page 293. There is a

form of inflammation of the appendix whose clinical course differs somewhat from the acute.

In this class of cases the patient has had an acute attack which was either not diagnosed or not operated upon. From time to time attacks of pain in the right iliac region occur of just sufficient severity to direct the patient's attention to them. The pain is usually of a dull aching character and incapacitates the patient for work for a day or so. It may be sharp and colicky in character, lasting, however, only a few minutes. To the latter class the term appendicular colic has been applied.

To those cases in which mild attacks of dull pain occur the term "chronic appendicitis" seems best fitted. Digestive disturbances, mucous stools, flatulency, and alternating constipation and diarrhea are often associated with the pain. On palpation a somewhat tender, elongated mass can often be felt in the appendix region, and the patient will usually refer the pain to this point. There is no accompanying rise of temperature or leukocytosis. If adhesions exist between the adjacent coils of intestine, there are indefinite colicky pains which radiate from the ileocecal region toward the rest of the abdomen. In palpating these cases to confirm the diagnosis, one will often feel a cylindrical mass in the right iliac region, which feels like a chronically inflamed appendix. This mass can be followed upward and downward much further than an appendix, and a similar mass is always to be felt in the left iliac region.

These cylindrical tumors are the markedly contracted cecum and ascending colon on the right, and the descending colon on the left side, respectively. The condition is often to be found in thin individuals, especially in neurasthenics who suffer from a chronic mucous colitis, so frequently accompanying a chronic appendicitis.

The differentiation of these chronic appendicitis cases, in women, must be made from chronic inflammatory conditions of the adnexa, and this usually can be done by careful bimanual examination; if necessary under an anesthetic. In addition, the pain of appendicitis is, as a rule, higher up than that arising from the adnexa. If much inflammatory exudation has occurred, it may be impossible to differentiate these two conditions, and they often coexist.

From gallstones these cases of chronic appendicitis can generally be distinguished by the fact that the tenderness in gallstones is just beneath the costal arch unless a Riedel lobe or hepatoptosis is present (Figs. 187, 222). In appendicitis, the tenderness and tumor are in the right iliac region, at McBurney's point, or along the lower half of the right border of the right rectus.

PRIMARY NEOPLASMS OF THE APPENDIX.

This has been regarded as such a varity that the subject of carcinoma and sarcoma of the appendix has been scarcely mentioned until recent years. That such neoplasms occur in the appendix with greater frequency than has been generally believed, can no longer be denied. Harte[1] was able to collect 101 cases of primary carcinoma of the appendix. The majority of these were found in the tip of chronically inflamed appendices. Some tumors were detected throughout the organ and a few were found in a totally obliterated appendix. The age of the patients ranges from ten to ninety years. Harte was also able to collect six cases of sarcoma of the appendix. The tumors vary from microscopic size to that of a normal ovary. They will give rise to symptoms apart from the accompanying appendicitis only when the growth has extended to the surrounding tissues, invading the cecum and becoming a carcinoma of this organ. The appendix is hardly recognizable at such a time as the primary seat of the growth. There are two classes of cases from a pathologic point of view: (*a*) the columnar cell type, as found in the stomach, intestine, and other parts of the alimentary tract, and (*b*) the spheroidal cell type, which closely resembles the basal cell carcinoma of the skin. The majority of the cases belong to this latter class, which explains why it may occur in early life. Ribbert's theory of the origin of these carcinomata of the appendix is generally accepted as the most plausible one, viz., that the tumors develop from epithelial nests which have been loosened from their attachments as the result of the chronic connective-tissue inflammation. The disease starts in the mucosa, the latter being replaced by spheroidal-cell growths from the crypts of Lieberkühn. The diagnosis of these cases as neoplasms is impossible before operation unless the cecum is involved, when a mass can be felt which may be either a carcinoma or a ileocecal tuberculosis (page 350). The history of repeated attacks of symptoms similar in every way to those of a chronically inflamed appendix, as described on page 393, is the rule. The only way in which it can be done is for surgeons to have every removed appendix carefully examined, if possible, microscopically as well as with the naked eye for evidences of neoplasm.

PRIMARY TUBERCULOSIS OF THE APPENDIX.

That a primary tuberculous infection of the appendix occurs is now beyond dispute. The source of the infection is the result of the ingestion of food, especially milk and butter from tuberculous cattle. Tubercu-

[1] "Annals of Surgery," June, 1908.

lous appendicitis may appear in either an acute or a chronic form. The former bears so close a resemblance clinically to the ordinary non-tuberculous forms of acute appendicitis that it has been considered in connection with that subject on page 394. The chronic form is the more common, and is seldom recognized as being of tuberculous nature until operation, the symptoms being those of the ordinary chronic appendiceal type. If the disease has spread beyond the walls of the appendix, the clinical picture changes to that of an ileocecal tuberculosis (page 350) or of an encapsulated tuberculous peritonitis in the right iliac region (see Fig. 249).

CHRONIC INTESTINAL OBSTRUCTION (ENTEROSTENOSIS).

Total occlusion of the intestine means a complete obstruction to the passage of feces, either through paralysis of the muscular fibers or owing to mechanical causes. The former, or paralytic ileus, is most often due to septic peritonitis, but may at times result from non-septic (neuropathic) causes.

The diagnosis of this neuropathic or paralytic form of intestinal obstruction can rarely be made if due to non-pyogenic causes. If caused by septic infection, the clinical picture is that of an acute peritonitis. The latter has been discussed in connection with its most frequent cause. Intestinal obstruction as an acute process is taken up in connection with the other acute abdominal affections, since the diagnosis of its existence must be made in connection with that of these conditions, in the majority of cases.

By chronic obstruction of the intestine (*enterostenosis*) is meant a chronic incomplete interference with the passage of feces. If, as not infrequently occurs, the occlusion of the lumen becomes complete, the clinical picture changes to that of acute intestinal obstruction (see page 319).

The only exception to the above statement is in those cases of strangulated hernia in which only a portion of the wall has been caught in the hernial opening (acute partial enteroceles). Although the lumen is not completely occluded from an anatomic point of view, yet the symptoms are the same as those in which the obstruction is complete and acute in its course.

Diagnosis.—The diagnosis of intestinal stenosis is made from a study of the history, the symptoms, and the physical examination, which conform closely to the following:

1. *Constipation.*—This is often the first symptom and may exist for

a long time alone. The patient begins to notice that a movement of the bowels is difficult without a purgative. Not infrequently the constipation alternates with attacks of diarrhea. Constipation is an early symptom in stenosis of the large but a very late one of the small intestine.

2. *Colic.*—Often this is the earliest symptom directing attention to the possibility of a stenosis. The attacks of pain may be quite severe or very mild. The pain is oftenest localized at the seat of the stenosis, but may be quite diffuse. These paroxysms of pain are often accompanied by vomiting.

3. *Visible Peristalsis.*—When vigorous peristaltic waves can be seen passing across the abdomen accompanying colicky pains, the diagnosis of enterostenosis is easily made. The loops above the stricture remain distended but a short time and can often be grasped by the hands of the examiner.

4. *Tympanites.*—The degree of abdominal distention varies according to the completeness of the stenosis. It may become so marked as to cause considerable dyspnea. Unsuccessful efforts to pass flatus when the abdomen is more or less distended should direct the attention of a physician toward the possibility of an enterostenosis.

5. *Condition of Feces.*—The presence of obstinate constipation, alternating at times with diarrhea, has already been mentioned. If the obstruction is low down, diarrhea may be almost constantly present. Blood and pus in the feces are often found, but are not pathognomonic of an enterostenosis. If ribbon-like bands of fecal matter are constantly passed they are of great value in making a diagnosis.

6. The *examination of the abdomen* for a palpable or visible tumor, and bimanual examination *of the rectum and pelvis in general* in both sexes, should be a matter of routine in every case. In high-seated rectal strictures due to carcinomata, proctoscopy is often the only means of making an early diagnosis (see page 401).

7. The *history* of the case may throw some light on the probable seat and nature of the process. Progressive loss in weight accompanied by symptoms of enterostenosis speak for malignancy (page 353).

8. One should inquire carefully for a history of syphilis, of tuberculosis, of previous typhoid, of dysentery, or of operations involving the various abdominal viscera, including the rectum.

In regard to the diagnosis of the seat of the stenosis, the localization of the pain and of the peristalsis may be of aid, in addition to the facts learned from abdominal and pelvic examination.

CONGENITAL IDIOPATHIC DILATATION OF THE COLON (HIRSCHSPRUNG'S DISEASE).

Owing to the great resemblance which the clinical picture of this interesting condition bears to that just described under enterostenosis, it has seemed advisable to call attention to it at this point. Hirschsprung

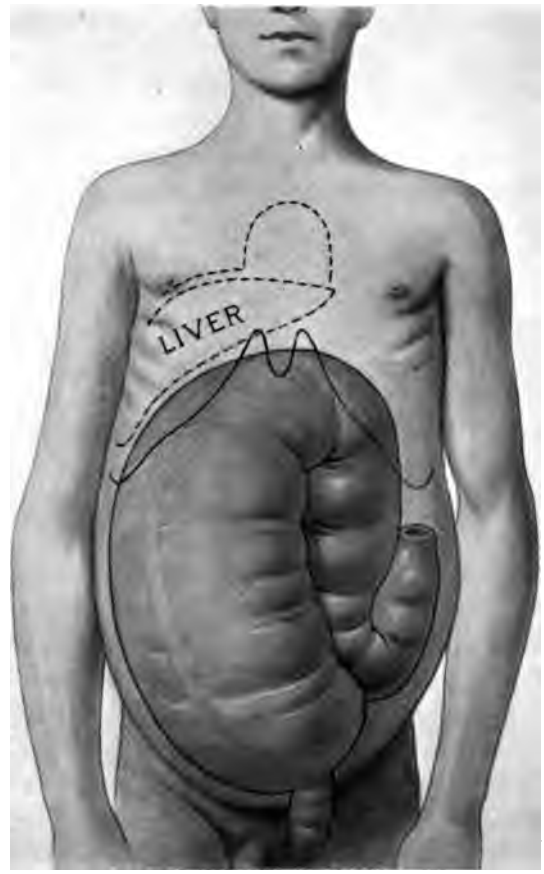


FIG. 248.—CONGENITAL DILATATION OF COLON (HIRSCHSPRUNG'S DISEASE).
Showing how liver, heart, and the abdominal viscera are all displaced by the enormously dilated viscus.

in 1886 first described a case of enormous dilatation of the colon which he believed to be of congenital origin.

The large intestine is the chief portion of the gut which is involved. The sigmoid alone (Fig. 248) is involved in more than one-third of the

cases.[1] The rectum and small intestine are rarely affected. There may or may not be evidence of mechanical obstruction of one form or another. In the congenital form there is no definite mechanical obstruction to be found at operation or autopsy. The most striking feature of the disease is the fact that the colon is dilated to a diameter of six or eight inches (Fig. 248). The dilated viscus almost fills the entire abdominal cavity, pushing aside and obscuring the small intestines, liver, and displacing the heart (Fig. 248). The large intestine disposes itself in two parallel limbs, running more or less perpendicularly. The marked abdominal distention and obstinate constipation are the most typical evidences of the disease. The distended abdomen may have been observed at birth, soon after or at a later period. The abdomen is barrel-shaped and the largest circumference is above the umbilicus. There may be no movement of the bowels for a week or even longer (three months in Gay's case). In children, the abdominal walls are thin and peristaltic waves may often be observed. The distended coils can at times be palpated through the abdominal wall. The area of liver and cardiac dullness (Fig. 248) are both greatly reduced. In the later stages dyspnea and cyanosis are quite marked. The diagnosis is based upon the chronic constipation and abdominal distention. The symptoms are less marked in adults than in children. The disease runs a very chronic course, although improvement occurs from time to time. The *x*-ray of the distended bowel, which has been filled with bismuth, is of great aid in doubtful cases.

FIG. 249.—AREA OF DULLNESS IN EXTENSIVE ENCAPSULATED TUBERCULOUS PERITONITIS.

[1] The author is indebted for much valuable information to the article of Dr. Finney in "Surgery, Gynecology and Obstetrics" of June, 1908.

TUBERCULOUS PERITONITIS.

In general, it may be said that tuberculous peritonitis occurs in five forms.

1. As part of a general miliary tuberculosis. As a rule, this cannot be diagnosed during life.

2. As a latent disease whose presence is only discovered accidentally at an operation for other conditions.

3. An acute form with tenderness, rigidity, fever, etc., or as a slower form resembling typhoid. Both of these have been described in the section on acute abdominal affections (page 272).

4. Those in which there is either an encapsulated exudate, or the formation of a firm mass resembling an abdominal tumor. These have been considered in the section on abdominal tumors (page 355), but will be enumerated again:

(*a*) Tumors due to rolling up, also called "puckering of the omentum."

(*b*) Encapsulated exudates (Figs. 249, 250).

(*c*) Tumors due to retraction, thickening, and adhesion of adjacent coils of intestine (Fig. 251).

FIG. 250.—LATERAL VIEW OF ABDOMEN IN A CASE OF TUBERCULOUS PERITONITIS.

Same case as shown in Fig. 249. Note the prominence of the lower half of the abdomen corresponding to the area of dullness shown in Fig. 249. Also observe the emaciation.

(*d*) Tumors due to enlarged mesenteric glands in children.

5. The ascitic form of tuberculous peritonitis.

The last-named cases present the clinical picture of free fluid in the peritoneal cavity. In this variety the amount of fluid is usually not as great as in ascites due to cirrhosis of the liver and there is a great tendency to early encapsulation. If a pleurisy or other evidences of tuberculosis exist, the diagnosis is easy, as in the case shown in Figs. 250 and

251. There is often a previous cervical lymph-node infection, or a suspicious family history.

In addition to the ascites, there is always more or less tympanites, so that the distention of the abdomen is greater than the amount of fluid, as evidenced by the dullness, would lead one to assume. There is often but little, if any, fever in the ascitic forms. There is usually more or less emaciation, although there are many exceptions. The presence of an encapsulated exudate, in addition to the free fluid, is quite diagnostic of tuberculous peritonitis. The use of tuberculin may clear up the diagnosis in doubtful cases, but it should be employed rarely. The various vaccination tests are described on page 828.

Differential Diagnosis of the Ascitic Form.—*Ascites Due to Cirrhosis of the Liver.*—An alcoholic history and the presence of a splenic tumor, as well as the more marked enlargement of the superficial veins, speak for cirrhosis. The ascitic fluid in cirrhosis is clear, watery, with low specific gravity, and contains only a trace of albumin, while in tuberculosis it contains more albumin and is often flocculent. The presence of encapsulated exudate also speaks for tuberculosis as well as slight evening rise of temperature. The inoculation of guinea-pigs with positive results or the use of tuberculin makes the diagnosis absolute.

Carcinomatous Affections Involving the Peritoneum.—In this condition the fluid is often hemorrhagic. Emaciation is much more rapid, and after the fluid has been evacuated tumor masses can be felt, which are harder and more nodular than those due to any tuberculous process.

THE RECTUM.

METHODS OF EXAMINATION.

The methods generally employed are: (*a*) Inspection; (*b*) Palpation; (*c*) Use of Specula.

(*a*) **Inspection.**—The best method for examination of the anus and lower portion of the rectum is in one of three positions. Where one is not provided with assistance, as in ordinary office work, the genupectoral position is in general the best. For hospital work, or where one has an assistant, the examination is best conducted with the patient in the lithotomy or in Sims' (semiprone) position. For the examination of the upper portion of the rectum the extreme knee-chest (genupectoral) posture is most suitable.

(*b*) **Palpation.**—This should never be omitted as a portion of the routine of diagnosis of abdominal conditions, and especially where symptoms pointing to rectal disease are complained of. The examination is

FIG. 251.—SECTION OF A COIL OF THE ILEUM FROM CASE SHOWN IN FIG. 249 ILLUSTRATING THE PATHOLOGY OF TUBERCULAR PERITONITIS.

Note the yellowish raised miliary tubercles between which the intestine is markedly hyperemic. The veiled appearance of the upper half is due to the fact that in this portion the pseudo-membrane has not been stripped off from the underlying tubercles. This membrane is shown in a wrinkled or rolled up manner at about the middle of the picture.

[illegible]

History.—[illegible]

1. *Pain.*—[illegible]

Relation to [illegible]? Is it independent of [illegible] accompany, or follow them? [illegible] in the rectum or around it, or does it radiate?

2. *Bowels.* [illegible] constipation or diarrhœa exist? Is the stool formed [illegible]? Is there [illegible] marked?

3. *Escape of Fæces, Pus, or Blood.*—[illegible] mucous, pus, or bloody discharge exist? How often [illegible] in what quantity, and does it accompany defecation [illegible]? Is the blood black and tarry, is it fresh and [illegible]? Is the stool merely streaked with blood?

4. *General Condition.* Whether any organic disease of the heart, liver, or kidneys exists? Has the patient a family or personal history of carcinoma, tuberculosis, syphilis, or gonorrhœa? Does any other pelvic condition exist?

5. *Character of Protrusion, if Any.* Does it bleed? Can it be readily reduced? Does it protrude during defecation, or at regular periods?

CONGENITAL MALFORMATIONS.

There are four chief forms of this condition:

(*a*) **Atresia Ani** (No. 1 of Fig. 252).—The anus is entirely absent or only represented by a slight depression. The bowel ends blindly and may be separated from the skin by a thin membrane. This is the most frequent form.

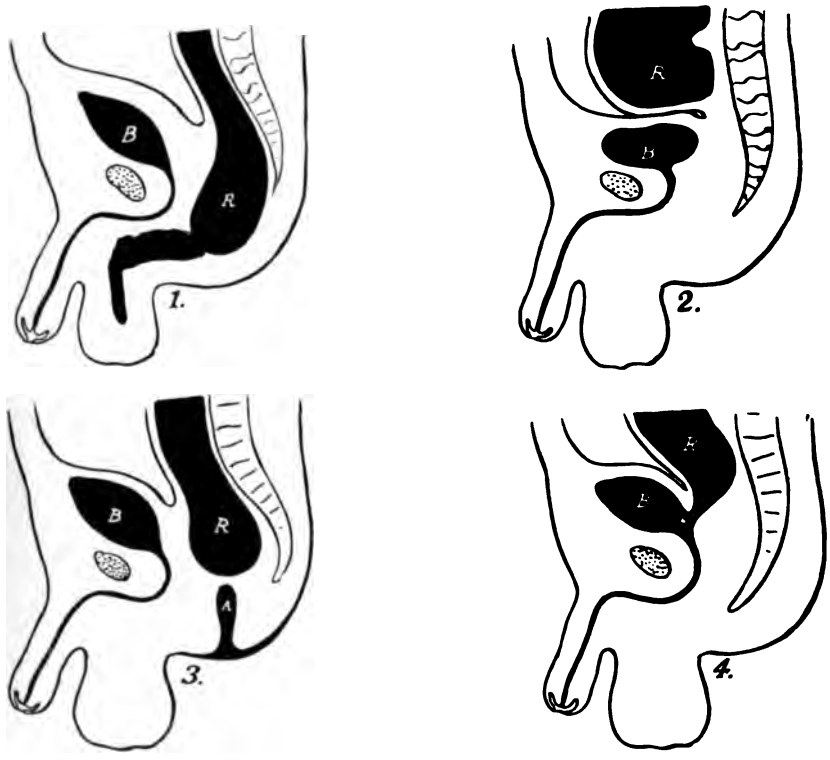


FIG. 252.—VARIOUS FORMS OF CONGENITAL MALFORMATIONS OF ANUS.

B, Bladder; *R*, rectum; *A*, primitive anus. In figure 4 the white arrow shows the communication between the bladder and rectum (Esmarch).

(*b*) **Atresia Ani et Recti** (No. 2 of Fig. 252).—The anus and rectum are not developed. The colon ends as a blind sac at the level of the sacral promontory. There is no indication externally of an anus.

(*c*) **Atresia Recti** (No. 3 of Fig. 252).—The rectum is formed down to the level of the sphincters. The anal portion is normally formed. Both, however, end blindly and may be separated only by a membrane or by a septum of connective tissue which is 1 to 1½ inches (3 to 4 cm.) thick.

(*d*) **Abnormal Opening of the Rectum** (No. 4 of Fig. 252).—

The anus is closed and the rectum opens into either the vagina or into the bladder, or even into the urethra.

The diagnosis of which one of these four conditions is present, can seldom be made before operation. As a result of retention of meconium the abdomen becomes greatly distended and vomiting follows. The latter may be feculent at an early period or only appear late, if a peritonitis has begun. In every new-born child which does not pass meconium within six to twenty-four hours after birth, the anus should be examined. A number of these cases have been operated upon successfully in which such an early diagnosis was made.

INJURIES OF THE RECTUM.

These may be divided into ruptures and penetrating wounds.

In the former class belong (*a*) those which accompany a fracture of the pelvis, (*b*) those following violent straining during defecation. This is more apt to occur in women who have previously had a rectocele. (*c*) Extension into the rectum of perineal lacerations during parturition.

Penetrating wounds follow stab or bullet wounds, falls upon a picket fence or other sharp object, careless introduction of enema points or of bougies.

In the diagnosis of an injury to the rectum the important points are the history, the accompanying internal or external signs of injury, and the escape of blood or of intestinal coils through the anus or vagina.

Later on there are the signs of infection with the formation of an ischiorectal abscess or of a more diffuse perirectal phlegmon. If the tear passes through the peritoneal attachment the signs of a septic peritonitis appear within a few hours after the injury.

The hemorrhage from a wound or tear of the rectum may be a concealed one, the blood accumulating in the rectum and pelvic colon while the patient shows signs of internal hemorrhage, such as pallor, syncope, rapid empty pulse, restlessness, etc.

In addition to the above-mentioned symptoms, a digital examination and the use of a speculum are necessary to confirm the diagnosis.

FOREIGN BODIES IN THE RECTUM.

These may be divided into three classes:

(*a*) Those which have formed within the body, *e. g.*, gallstones, enteroliths, impacted feces. The last named may attain the size of a child's head.

(*b*) Those which have been swallowed, *e. g.*, fish-bones, peach-stones,

rings, all sorts of objects swallowed by the insane, such as forks, spoons, nails, balls of hair, etc.

(*c*) Those which are introduced through the anus, either accidentally or with some object in view, such as aiding a bowel movement or in the insane, or in sexual perverts.

The diagnosis may be made in many of the cases if attention has been directed to the rectum through one of the following symptoms:

(*a*) The occurrence of tenesmus accompanied by the passage of blood or mucus in elderly people, who have suffered from obstinate constipation. In others the first signs may be inability to urinate through pressure on the urethra.

FIG. 253.—MARKED ELEPHANTIASIS OF THE EXTERNAL FEMALE GENITALIA AND SYPHILITIC CONDYLOMATA OF RECTUM.

1, Elephantiasis of the clitoris; 2, elephantiasis of left labium majus; 3, similar condition of right labium minus; 4, syphilitic condylomata of rectum.

(*b*) The occurrence of evidences of an infection of the perirectal tissues.

(*c*) The history of swallowing some foreign body or its introduction through the anus.

One should never neglect under the above conditions to make a thorough digital examination and to combine with it, the use of the speculum.

INFLAMMATORY PROCESSES AND THEIR RESULTS.

These include: (*a*) Pruritus ani, (*b*) proctitis, (*c*) perirectal infection (phlegmons and ischiorectal abscesses), (*d*) fistulas, (*e*) ulcerations, including anal fissure.

Pruritus Ani.—This is often associated with chronic constipation, hemorrhoids, etc., and in some cases, no cause can be found. It causes an intense itching, especially at night. The skin of the anal region becomes of a silvery white color and is greatly thickened. The disease often appears periodically with each menstruation or pregnancy.

Proctitis.—This occurs in an acute and chronic form.

In *acute proctitis* there is (*a*) pain in the rectum radiating to the coccyx, perineum, or thighs. (*b*) Constant straining and the passage of

mucus and blood. There is intense pruritus ani. (*c*) Constant desire to urinate. There may be retention of urine. (*d*) Both external and internal sphincters are found markedly contracted when the finger is introduced. The rectum feels hot and is very tender, and if a speculum can be introduced the mucosa is seen to be greatly congested and swollen.

Chronic Proctitis.—The most common causes in children are the presence of polypi or of pin-worms; rarely it is due to a congenital syphilis. In adults it either follows an acute attack or is chronic from the beginning, and then is most frequently due to syphilis or gonorrhea, less often to tuberculosis or a prolapse.

There are two forms, a hypertrophic, in which ulcerations and papillomatous excrescences occur on the mucosa, and an atrophic or stenosing form. The two may be combined in some cases. In the latter, which is most often due to syphilis, there is either circumscribed or more diffuse infiltration of the entire thickness of the rectal wall and of the perirectal tissues, resulting in the formation of strictures (see page 413).

The *diagnosis of the hypertrophic form* may be made if there is a history of a preceding acute attack followed by frequent bowel movements, consisting principally of pus and mucus. This condition may alternate with constipation. In some cases there is but little tenesmus or pain, while in others it is very marked.

Perirectal abscesses and fistulæ very often complicate the clinical picture, especially if the pus cannot readily escape through the anus.

There is in many cases the history of a gonorrhea or the presence of fissures, hemorrhoids, or fistulæ. Examination with the finger or speculum, and in some cases through the proctoscope, will confirm the diagnosis in the hypertrophic form.

From carcinoma, the hypertrophic form can be differentiated by the fact that there is soft mucosa between the individual polypoid elevations. There is also an absence of the marked induration of cancer.

In many doubtful cases a microscopic examination should be made.

Multiple polypi in children and young adults may resemble it, but these are usually larger and there is no ulceration between them. In some cases, if ulcerations exist, it is impossible to make a distinction.

PERIRECTAL INFECTION.

Diffuse Perirectal Phlegmon.—This may follow insufficient drainage of an ischiorectal abscess or arise through extension of suppuration from neighboring structures like the prostate or uterus.

Most frequently it follows some operation upon the rectum in which infection has occurred.

The diagnosis can be made from the local signs of infection in the tissues around the anus and those of a general infection. These are

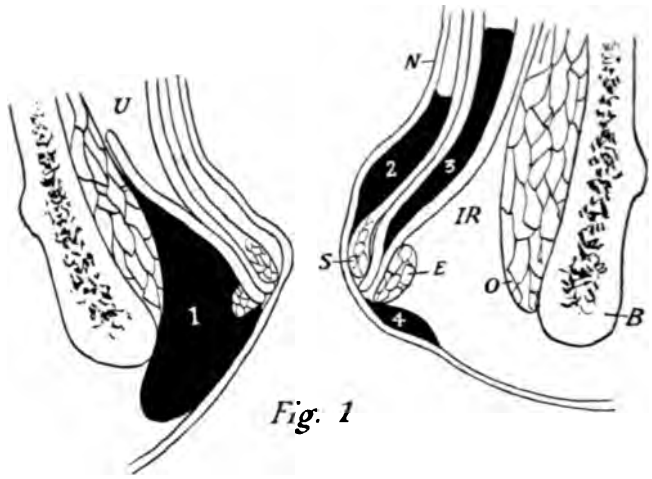


Fig. 1

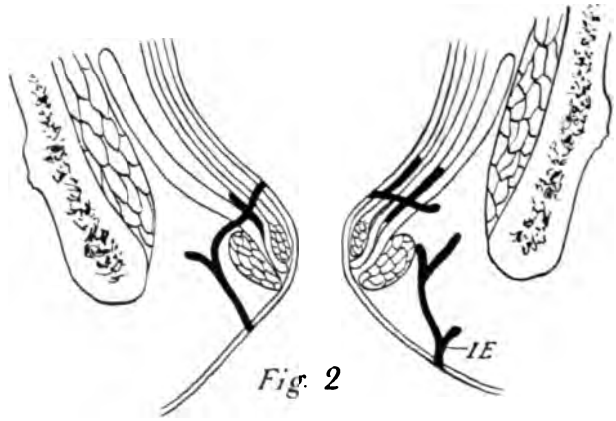


Fig. 2

FIG. 254.—VARIOUS FORMS OF ISCHIORECTAL ABSCESSES AND FISTULÆ.

Fig. 1, Locations of ischiorectal abscesses: *IR*, Ischiorectal fossa; *E*, external sphincter; *S*, internal sphincter; *B*, ramus of ischium; *U*, space above levator ani muscle; *N*, mucous membrane of rectum. The same figures apply to the lower illustration. 1, Most frequent form of ischiorectal abscess, pushing skin of anal region outward; 2, submucous abscess above the internal sphincter; 3, abscess situated above levator ani muscle in pelvic connective tissue; 4, subcutaneous extrasphincteric abscess. Fig. 2, On the left-hand side is seen a complete internal and external fistula. On the right side is seen a fistula situated beneath the mucous membrane and burrowing deeply into the upper portion of the ischiorectal fossa. *IE* of this lower illustration represents an incomplete fistula, having only an external opening.

marked infiltration, redness, pain, and rise of local and general temperature.

In a case recently seen the most marked symptom was a retention of

urine through pressure on the urethra. The infiltration may extend over the perineum toward the scrotum and resemble an extravasation of urine, but in the latter there is more involvement of the scrotum, while in perirectal phlegmon the chief external swelling is around the anus. Unless the condition is relieved the septic infiltration spreads and signs of severe general intoxication appear.

Circumscribed Suppuration.—This occurs in other locations than the ischiorectal fossa, and it is often of importance to recognize the exact location of a focus.

The abscesses may be divided (Fig. 254) into:

1. Intrasphincteric abscesses, *i. e.*, inside of the sphincter ani.
   (*a*) Subcutaneous.
   (*b*) Submucous.
   (*c*) Both of above combined.
2. Extrasphincteric abscesses (ischiorectal).
3. Abscesses of the superior pelvirectal space (deep-seated).

Diagnosis of Intrasphincteric Abscesses.—The first sign is usually pain referred to the anus, accompanied by tenderness on pressure. Examination with the finger will reveal in the first variety (subcutaneous) an area of quite circumscribed tender induration just beneath the skin and close to the anal margin. In the submucous variety the finger must be inserted through the anus. One then feels a boggy, tender swelling just above the anal margin beneath the mucosa. When these two are combined (submucocutaneous) the external indurated area passes directly over into the one situated within the anal margin.

The local symptoms are accompanied by fever, constipation, malaise, etc.

In many cases the abscesses have already ruptured spontaneously when the patient is examined. One will then find an external fistulous opening which does not lead alongside the rectum, as do the true anal fistulæ. In case a submucous abscess has burst, the opening will be found just above the external sphincter and the cavity lies beneath the mucosa quite superficially.

Extrasphincteric Abscesses.—These are the varieties ordinarily spoken of as ischiorectal. They may follow any of the intrasphincteric forms or arise in the deeper parts of the ischiorectal fossa.

If the infection begins near the skin, the symptoms of suppuration are more marked than if it begins deeply.

There is pain referred to the ischiorectal region in the superficial form, accompanied by tenderness on pressure. The skin over the

ischiorectal region becomes red, edematous, and hot, and there are soon evidences of fluctuation.

Frequently the abscess breaks spontaneously.

In the deeper variety the symptoms are often quite obscure at first. There is deep-seated pain accompanied by signs of general infection, such as high fever, prostration, rapid pulse, etc.

If the finger is pressed upon the ischiorectal region either from without or through the rectal wall, there is considerable tenderness. The signs of infiltration of the skin of the ischiorectal region appear at a later period.

If the pus is not evacuated an abscess of the upper pelvirectal space may result, or the pus may travel around the rectum to the opposite ischiorectal region. The abscess may open spontaneously at some distance from the anal margin.

Abscesses of the Superior Rectal Space (Fig. 254).—These may result from suppuration in the prostate, in the periuterine tissue, in the rectum and bones of the pelvis. Abscesses of this space may also be the result of neglected ischiorectal abscesses, or, on the other hand, abscesses of this space can perforate into the ischiorectal fossa (Fig. 254).

The diagnosis of these abscesses is often very difficult. There is deep-seated pain, fever, and signs of general septic intoxication. Locally there is, in addition to the pain, often retention of urine, constipation, and infiltration of the tissues around the rectum. Through rectal or vaginal palpation one can distinguish the point of greatest tenderness. The differentiation of this variety from abscesses of the prostate, pelvic abscess, or bone suppuration is often very difficult, and at times impossible, except from the history and the fact that the tenderness and induration in this form are most marked in close proximity to the rectum.

Fistula in Ano.

The majority of these follow an infection of the perirectal tissues with abscess formation, whether due to the ordinary pus organism or the tubercle bacillus.

The common varieties are shown in Fig. 254. They are:

1. *Complete.* The external opening is located either close to the anus or at some distance away in the gluteal or perineal regions. The internal opening is usually posteriorly, at the junction of the two sphincters, seldom above it.

2. *Incomplete Internal.* There is only an inner opening leading into a blind sinus. These are infrequent.

3. *Incomplete External.* The sinus in the majority of cases lies just

beneath the skin, and it is formed from one of the intrasphincteric variety of abscesses described on page 407. There are, however, a number of these which are the result of a complete fistula in which the inner opening has closed.

The rarer varieties of fistulæ are:

(*a*) Complete internal (both openings internal).

(*b*) Complete external (both openings external to the rectum).

(*c*) Rectovaginal and rectovesical.

(*d*) Horseshoe. (The sinus runs around the rectum like a horseshoe. There are often many external openings and branch sinuses running in all directions.)

The diagnosis of a fistula is not difficult if an external opening exists from which pus is discharged. This may cease for a time but reopen again.

The incomplete internal fistulæ cause some pain on defecation and the discharge of pus.

In order to demonstrate the course of a fistula a flexible probe should be used, aided by the finger inserted into the rectum. *One should never use any force in passing a probe along the tract.*

In the majority of fistulæ the inner opening is located posteriorly, about half an inch above the anus, and can be felt as a depression, or more often a slight elevation. The opening may in rare instances be at any point. At times the injection of methylene-blue into the external opening or the injection of bismuth followed by the taking of an *x*-ray picture (Beck) will aid in finding the inner one.

The presence of openings on both sides of the anus indicates a horseshoe fistula.

In incomplete internal fistula one feels an induration on inserting the finger into the rectum and a depression where the fistulous opening is located. For the diagnosis of this, the use of a speculum is usually necessary. Tuberculous fistulæ usually accompany the same disease elsewhere, and the external opening is large, lined by pale, flabby granulations, and the edges are bluish and often undermined. Non-tuberculous fistulæ may, however, exist in phthisical patients.

Anal Fissure.

The most prominent symptom of this condition is pain of a severe character on defecation. On account of this pain there is marked constipation. The other symptoms are intense pruritus and reflex disturbances, such as increased desire to urinate. The diagnosis can be made from the severity of the pain on defecation and from the local examination.

The latter will often show an acute inflamed external hemorrhoid, the "sentinel pile," on the inner side of which the painful ulcer or fissure can be seen.

In some cases digital examination is necessary. The sphincter will be found tightly contracted and the finger or probe can be made to touch every point until the painful spot is found. The latter is slit-like and has somewhat hard edges.

NON-MALIGNANT ULCERATION.

These may be (*a*) traumatic, (*b*) catarrhal, following acute or chronic proctitis, (*c*) dysenteric, (*d*) gonorrheal, (*e*) tuberculous, (*f*) syphilitic, (*g*) varicose.

The chief symptoms of all of these are the same as those of a chronic proctitis, viz., the discharge of pus and blood accompanied by diarrhea. The evacuations are usually accompanied by tenesmus and hemorrhage in a greater or less degree.

The diagnosis can be made (*a*) by taking an accurate history; (*b*) by a careful examination of the rest of the body for evidences of syphilis, tuberculosis, etc.; (*c*) by a local examination. In almost all varieties there is marked contraction of the sphincter. In syphilis ulceration is most frequent in the tertiary stage, and especially marked in the lower part of the rectum. The same is true for gonorrhea. Both cause marked infiltration of the rectal walls and multiple ulcerations.

Tuberculous ulcers have an irregular shape, are of large size, have undermined edges, and the base is not indurated. It is most frequent around the anal margin or close to the external sphincter and is often accompanied by a fistula.

In some cases of rectal ulceration an exact diagnosis of its nature is very difficult, if not impossible.

HEMORRHOIDS.

These are usually divided into:

(*a*) External (covered by skin).

(*b*) Internal (covered by mucous membrane).

(*c*) Combination piles (*a* and *b* combined).

It is important from a diagnostic point of view to distinguish:

(*a*) Those which are secondary to pregnancy, diseases of the heart or liver, uterus and adnexa, or to tumors of the rectum or prostate.

(*b*) Those which are primary.

The diagnosis of hemorrhoids can be readily made in the majority of cases. In the uncomplicated cases the patients complain of a feeling

of weight, of an itching or burning sensation and occasional tenesmus. There is but little pain unless an ulcer or a fissure coexists. If internal hemorrhoids prolapse there is some pain until they are returned.

In many cases the patient's attention is first directed to the rectum on account of frequent bleeding. The latter may be quite profuse or be small in amount and occur with every bowel movement, so that the patient becomes quite weak and anemic.

External hemorrhoids are usually visible upon simply exposing the anal region. Internal hemorrhoids are seldom to be seen unless the patient strains or they protrude during defecation or they have become inflamed.

External hemorrhoids are either soft, fleshy, bluish masses, or firm skin tags which cannot be reduced. If of the softer variety they can be caused to disappear by pressure, but the mass rapidly reappears. Internal hemorrhoids are covered with dark red, swollen membrane. They may be single or multiple, the latter forming a fringe around the anal margin when they are protruded.

Allingham distinguishes three kinds of the internal variety—capillary, venous, and arterial. The first named are deep red, bleed readily and profusely. The venous are quite large, firm, of a pale livid color, do not bleed much, and readily protrude. The arterial are firm, large, bleed readily, and the blood spurts as from an artery.

Of these, the capillary and arterial are rare, the venous being the common variety.

The complications of hemorrhoids are thrombosis, inflammation, strangulation, and sloughing.

Thrombosis usually occurs in the external variety. The hemorrhoid becomes very hard and greatly enlarged. It causes the patient great discomfort and frequent attacks of tenesmus.

Inflammation most often complicates the internal variety. The hemorrhoids become very painful and firm and remain protruded.

Sloughing and strangulation are rare complications.

PROLAPSE.

This condition of protrusion of the rectum is quite frequent in children and in old people, but may occur at any age. It is more frequent in women than in men, associated in the former with general enteroptosis and uterine prolapse. The most common form is a prolapse of the mucous membrane only. This is called a partial prolapse and usually occurs in children.

A complete prolapse of all the coats (Fig. 255) occurs less frequently than the partial form. It is the usual form in adults.

The diagnosis of prolapse is easy. The protrusion embraces the entire circumference of the bowel and is of reddish color with a depression in the center. The partial prolapse of children can be readily reduced and protrudes only when the child strains as at a stool, etc. The complete prolapse remains out most of the time and the mucous membrane becomes very sensitive and bleeds easily. The condition can be dis-

FIG. 255.—COMPLETE PROLAPSE OF THE RECTUM

L, Depression corresponding to lumen of rectum; PM, prolapsed mucous membrane of rectum.

tinguished from hemorrhoids by the fact that in the latter the protrusion is irregular and one can feel the separate, soft, dark blue, hemorrhoidal tumors. Epithelioma of the anus feels quite hard and cannot be reduced. The surface is often ulcerated or covered with cauliflower excrescences. An intussusception, when it protrudes, may resemble a prolapse. The finger when passed around the edge of the protrusion will find a groove or sulcus between the skin and the mass, while in prolapse this is absent.

STRICTURES OF THE RECTUM.

These may be divided into annular and tubular, according to whether the stenosis is circumscribed or more diffuse. For diagnostic purposes a good division is into:

1. Extrinsic, caused by pressure from without, as from cancer of the prostate or rectum or from pelvic exudates, or tumors of the bones of the pelvis.

2. Intrinsic, due most often either to (*a*) syphilis, (*b*) carcinoma, or (*c*) gonorrhea.

Congenital, traumatic, dysenteric, and tuberculous strictures are very rare in their occurrence and their existence is denied by many experienced proctologists.

The diagnosis of the existence of a stricture is not difficult from a consideration of the symptoms and local findings. As to the etiology of any particular case, the question is a more difficult one. The most prominent symptom is constipation, which may increase to complete stenosis, followed by symptoms of intestinal obstruction. In some cases the first symptom is a persistent diarrhea, accompanied by marked tenesmus. In the non-malignant cases there is a frequent discharge of pus and mucus. Pain is not a prominent symptom, but in the malignant cases there may be marked radiation of pain along the sciatic nerves.

The local examination should be made first with the finger; then, if it is necessary, the speculum or proctoscope may be used. The systematic use of the latter is to be warmly recommended where symptoms of stenosis exist. It should be combined with the examination of the lower rectum with the finger and speculum. One can make an early diagnosis of a high-seated stricture by this means better than by any other.

In making a diagnosis of the cause of the stricture the history is of great value. Syphilis is the cause of the majority of non-malignant strictures, and careful inquiry must be made as to the possibility of an acquired or congenital syphilis. Search should be made for evidence of the disease.

Gonorrheal stricture is more frequent in women and can only be diagnosed from the history and the absence of syphilis. Stricture from extrinsic causes can be diagnosed by the examination of the pelvis, the uterus, the prostate, etc.

To differentiate a non-malignant from a malignant stricture the following table from Ball will be of aid:

DIFFERENTIAL DIAGNOSIS BETWEEN NON-MALIGNANT AND MALIGNANT STRICTURE.—(*Ball.*)

NON-MALIGNANT STRICTURE.	MALIGNANT STRICTURE.
1. Generally a disease of adult life.	1. Generally a disease of old age.
2. Essentially chronic, and not implicating the system for a long time.	2. Progress comparatively rapid and general cachexia soon produced.
3. The orifice of the stricture feels like a hard ridge in the tissues of the bowel. Polypoid growths, if present, are felt to be attached to the mucous membrane.	3. Masses of new growth are to be felt either as flat plates beneath the mucous membrane and the muscular tunic, or as distinct tumors encroaching on the lumen of the bowel.
4. Ulceration of the mucous membrane may be present, but without any great induration of the edges.	4. Ulceration, when present, is evidently the result of breaking down of the neoplasm; the edges are much thickened and infiltrated.
5. The entire circumference of the bowel is constricted unless the stricture is valvular.	5. Generally, one portion of the circumference is more obviously involved.
6. Pain, throughout the whole course, in direct proportion to the fecal obstruction, and complained of only during defecation.	6. In the advanced stages pain is frequently referred to the sensory distribution of some of the branches of the sacral plexus, due to direct implication of their trunks.
7. Glands not involved.	7. The sacral lymphatic glands can sometimes be felt through the rectum to be enlarged and hard. Inguinal glands hard.

NEOPLASMS OF THE RECTUM.

Polyps.—These are most frequently found in children. They are adenomata, and usually single, with a narrow, long pedicle. Less often they are multiple and sessile.

They may exist for years without causing any symptoms. It is only after they begin to bleed or are caught within the anal orifice that they give rise to symptoms. They may be accompanied by the signs of proctitis (page 404).

Whenever a child strains at stool, without showing evidences of a prolapse, and passes blood frequently, the examining physician should insert the little finger into the rectum and examine the entire circumference of mucosa. A polyp can be readily recognized as a soft, cherry-like, very movable tumor attached to the mucosa by a narrow pedicle. When it protrudes through the anus, their mobility and the presence of a pedicle render differentiation from a hemorrhoid easy. The attachment of the pedicle may be high up in the rectum or even in the sigmoid.

In prolapse the protrusion involves the entire circumference of the anus, has no pedicle, and a distinct tumor cannot be felt.

Broad, sessile polyps occurring in older persons have a tendency to become malignant.

Carcinoma of the Rectum.—This is predominantly a disease of old age, but may occur between fifteen and thirty. There are two forms—the epithelioma of the anus and the adenocarcinoma of the rectum proper. The latter form is thirty times more frequent than the former. Carcinoma of the rectum proper arises most often in one of two places: (*a*) In the ampulla, either as a placque-like or as an annular growth; (*b*) at the junction of the rectum and pelvic colon (sigmoid). In the second situation the tumor most often occurs in an annular form. The diagnosis of an epithelioma of the anus is not difficult. It is found either as (*a*) a wart-like, firm tumor with indurated base, involving a variable degree

FIG. 256.—NON-MALIGNANT PAPILLOMA OF THE ANUS ("International Text-Book of Surgery").

of the circumference of the anal orifice, or as (*b*) a crater-like ulcer with marked indurated edges and base. The age of the patient and the characteristic induration of the growth render a differentiation from ordinary soft venereal warts or hemorrhoids easy. In cancer of the anus there is early induration of the inguinal nodes.

Carcinoma of the rectum proper is more difficult to recognize. There are no characteristic symptoms for this condition, but its presence must be thought of when patients, above forty, complain of diarrhea accompanied by the discharge of pus and mucus, a sensation of weight, pain radiating into the thighs and back, and straining at stool.

In some cases, obstinate constipation alternating with attacks of diarrhea and the occasional passage of blood will be the only symptoms. With both of these clinical pictures there is often a gradual loss in weight and in strength.

If the cancer is located high up near the sigmoid there are indefinite symptoms of enterostenosis, colic-like pains, etc. (page 395). In women such a tumor has been mistaken at times for an ovarian or uterine tumor, or for a displaced uterus. For carcinomata situated in the ampulla digital examination will usually suffice. For those which cannot be reached by the finger, the use of the proctoscope cannot be too warmly recommended. Bimanual examination under anesthesia is also of great aid for these high-seated cancers. The growth may be felt as a crater-like ulcer with hard edges and base situated only on one side of the rectal wall, or it forms an annular, band-like constriction which causes the rectum to feel board-like and to become firmly fixed to the surrounding structures.

FIG. 257.—CARCINOMATOUS ULCER OF POSTERIOR WALL OF RECTUM.
Observe the papillomatous condition of the edges and the crater-like excavation of the center of the ulcer.

The chief condition from which malignant stricture of the rectum must be distinguished is syphilis. This has been considered on page 413.

RENAL AND VESICAL LESIONS.

In this section the chief diseases of the kidney and ureter are considered, to which reference has not been previously made. The subject of tumors of the kidney, whether due to hydronephrosis or neoplasms, has been discussed under abdominal tumors on page 360. The same is true of movable kidney. The subject of pyelonephritis is taken up under acute abdominal conditions on page 278. Injuries of the kidneys are treated under abdominal injuries in general on page 263. In the following pages renal and ureteral calculus, tuberculosis of the kidney, and anuria are taken up. Ureteral catheterization and cystoscopy as aids to the diagnosis of renal diseases are considered under "Methods of Exami-

nation," on pages 832 and 847. The value of and the various means of determining the functional capacity of each kidney are also considered in the same section.

TUBERCULOSIS OF THE KIDNEY.

The two modes of infection are the hematogenous and the urogenous. Two distinct hematogenous foci may be present in the kidney and epididymis. A urogenous infection is possible only when a tuberculosis is present in the opposite kidney or when the bladder has become infected from a tuberculous epididymis. Hematogenous infection is the rule, while urogenous infection is the exception. There are four principal pathologic forms: *(a)* A sclerosing or infiltrating form. Many tubercles

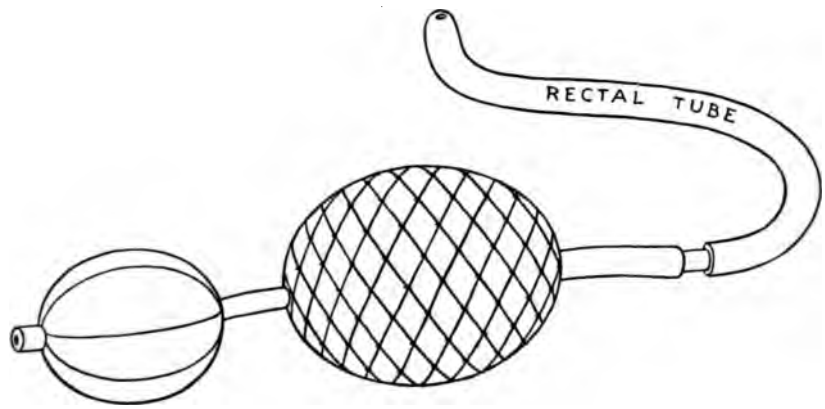


FIG. 258.—APPARATUS TO BE EMPLOYED FOR INFLATING THE COLON FOR DIAGNOSTIC PURPOSES
The rubber bulb of a Paquelin cautery is joined by means of a glass tube to an ordinary rubber rectal tube.

are combined with marked interstitial changes. *(b)* Tuberculous ulceration of the papillæ. In such cases a severe hematuria may be the first sign of the presence of the disease. *(c)* The cavernous form, which is the most frequent, and results in the formation of cavities lined with caseous granulation. *(d)* A tuberculous pyonephrosis. This is the end-stage of the cavernous form. When, as in some cases, the tuberculous foci have no communication with the pelvis, the lesion is spoken of as a "closed focus," and the kidney may be quite extensively destroyed before any evidences of the disease appear in the urine.

It is at present a well accepted fact that the majority of cases are due to hematogenous infection, the disease never being primary in the ureter or bladder. It is equally true that in about 90 per cent. of individuals who have renal tuberculosis the disease is unilateral, and that

it remains so until infection of the opposite kidney occurs at a late stage. The infection of the other kidney occurs by way of the bladder, and then ascending infection from the bladder along the ureter to the kidney.

Clinically there are three modes of onset:

1. Those in which the symptoms of chronic cystitis are present, which do not yield to the usual treatment.

2. Those in which the symptoms are those of a chronic pyelitis, *i. e.*, pyuria of renal origin lasting for years in some cases, before a suspicion of tuberculosis is aroused.

3. Those in which a sudden hematuria is the first symptom.

FIG. 250.—TUBERCULOSIS OF THE KIDNEY IN ITS INCIPIENT STAGE.

1, Caseous broken-down foci at apex of the pyramids in the upper pole of the kidney; 2, miliary tubercles in the cortex.

1. Those with symptoms of cystitis constitute the majority, the patients often being treated for this for a long time. The first and earliest symptom noticed in this class of cases is that there is *increased frequency of urination*, especially at night. Some patients complain of being obliged to urinate immediately, in other patients incontinence is present, while in a third group there is vesical tenesmus and burning at the end of urination and some pain.

2. In the second mode of onset there is a painless pyuria with little or no bladder irritability, the urine is acid in character and contains tubercle bacilli. In some of these cases there may be recurrent attacks of high fever, with or without preceding chills. Such an atypical clinical picture

of renal tuberculosis is the result of mixed infection with colon bacilli or the ordinary pyogenic organisms, and can only be distinguished from the forms of pyelonephritis described on page 278 by finding tubercle bacilli in the urine.

3. In the third class, a sudden severe hematuria of brief duration may be the first symptom to direct attention to the kidneys. This initial hematuria is not a frequent occurrence.

Diagnosis.—In making a diagnosis one must consider the following factors:

1. *The various modes of onset as just described*, so that, in general, pyuria in adults between twenty and forty, preceded or not by signs of bladder irritability and fever, should lead to further examination.

2. *Urinary Changes.*—The reaction is acid, there are but few casts, there is a trace of albumin in the filtered specimen, many pus-cells and tubercle bacilli. In some cases the urine may be quite clear at first. Tubercle bacilli can be best found if several pints of freshly voided urine are used for sedimentation and the sediment stained. If this is unsuccessful a guinea-pig should be inoculated.

3. *Pain and Renal Enlargement.*—As a rule, there is but little pain. In some cases there is a dull aching in the lumbar region on one side, for years. In a few cases paroxysmal attacks like renal colic occur, but these are rare.

In the majority of cases there is palpable enlargement of the affected kidney (nineteen in twenty-four cases observed by Israel), to about twice the normal size. Unfortunately this enlargement occurs at such a late stage of the disease as to be of little value. At the time when diagnosis would be of the greatest aid to the surgeon, viz., early enough to perform a nephrectomy, the enlargement of the kidney is such an inconstant factor as to be of little value. The normal kidney may be compensatorily enlarged, and this is apt to be misleading. Enormous enlargement is infrequent. The kidney, if palpable, may be tender, and in thin women one may also feel the greatly thickened ureter as a hard, tender cord. The tenderness is also a very unreliable sign. It may be absent in many advanced cases. It is most apt to occur in the diffuse infiltrating form.

4. *General Symptoms.*—The entire body should be searched for primary foci. Every patient will show a gradual loss in weight and strength and increasing anemia; this is most marked if both organs are involved. There may be either fever of an intermittent type or a difference of one to three degrees between the morning and evening temperature (hectic type).

The injection of tuberculin for diagnostic purposes (see page 828) is justifiable, and is indicated if tubercle bacilli cannot be found.

5. *Cystoscopic Examination and Ureteral Catheterization.*—The improvements in this direction have greatly aided in making an early diagnosis of this affection possible and their use should never be neglected.

Through the cystoscope one can see ulcerations in the bladder around the ureteral orifices. The edges of these are everted, swollen and red, and there is often an irregular, dentated, funnel-like ulcer present (golf-hole orifice).

When there are no such vesical changes, only catheterization of the ureters will show the kidney affected, and this can be done on the suspected side only.

NEPHROLITHIASIS (RENAL CALCULI).

Renal calculi vary greatly in their shape and size. Those found in the parenchyma are usually quite small and are oval or round. In the calyces they become larger and often have the shape of a calyx.

Those which are found close to the orifice of the ureter are longer and are more often hammer-shaped, having a broader upper and a narrower distal portion. Every calculus causes more or less damage both to the kidney in which it is located and to the opposite one. One of the most important factors in the development of the surgery of the kidney during the past ten years has been the information which the methods of determining the functional capacity of each kidney have given us, as to the extent of such damage to the parenchyma. The renal changes due to the presence of calculi vary greatly according to whether the urine has remained aseptic or whether it has become infected.

As long as the urine remains aseptic and the calculus is in such a position as not to obstruct the outlet of the pelvis and cause back pressure upon the parenchyma, but little damage is done.

In the aseptic calculous kidney the possible pathologic changes are: (*a*) a contracted kidney, due to the production of connective tissue between the tubules; (*b*) a variable degree of hydronephrosis, or more properly speaking uronephrosis. As a rule, this second sequel is of minor degree unless the ureteral orifice is almost completely blocked.

In the infected calculous kidney, the possible sequelæ of such infection are: (*a*) A pyelitis which is in reality seldom confined to the pelvis alone, but extends upward along the tubules and involves the parenchyma. (*b*) A pyelonephritis with multiple miliary and larger abscesses scattered through the medulla and cortex (Fig. 10[illegible]

pyonephrosis. This is an advanced stage of the condition described as pyelonephritis, and is the result of the disintegration of the parenchyma, with the formation of large cavities separated by septa and containing pus and calculi. If the ureter is blocked, the entire kidney is converted into a sac containing pus and calculi. (*d*) An infected hydronephrosis. In this an aseptic hydronephrotic or uronephrotic calculous kidney becomes infected, and the dilated pelvis or calyces, instead of containing urine alone, contain both urine and pus, there being sufficient parenchyma left to continue the excretion of a fair amount of urine. (*e*) The various forms of paranephritic complications of an infected calculous kidney. Here we may have either a paranephritic abscess or the production of granulation, and later of scar tissue, around the kidney. Finally we may have (*f*) a part or the entire kidney parenchyma replaced by fat whose origin is probably in the capsular fat.

The effect of calculi in one kidney is to cause hypertrophy of the opposite one. In some cases the other kidney is either absent or has remained in its state of embryonal development called hypoplasia. If infection is present in one kidney, the opposite one is often secondarily infected through the bladder and along its own ureter, termed "ascending infection."

If calculi are present in both kidneys, the changes in each one go on independently of the other, depending upon whether one or both are infected. We thus see that many pathologic changes take place in a kidney which is the seat of calculi. The extent of destruction of renal parenchyma can be fairly accurately measured by our modern means of determining the functional capacity of each kidney, described more fully on page 852.

In some cases renal calculi, like gallstones, may be present without causing any symptoms. There are, in general, two classes of cases:

1. Those in which symptoms directly referable to the kidney appear, as renal colic, hematuria, or anuria.

2. Those in which there are no active symptoms, the so-called quiescent cases.

1. Those in which active renal symptoms appear.

In the majority of these patients it is the occurrence of one or more attacks of renal colic which attracts the attention of the physician. The first point to determine in these cases is whether the attack had all of the characteristics of a typical renal colic. The second fact is to ascertain by a process of exclusion, whether the attack of pain, etc., might not be [redacted] other renal or ureteral conditions which produce colic. There are

cases of renal or ureteral calculi in which there are no active attacks of renal colic, but there is a more or less constant pain of a dull, aching character over the affected kidney or ureter. This pain may be referred, however, to the opposite side, as the result of a renorenal reflex. The pain is always aggravated by motion, such as walking, jumping, etc. In bilateral calculi the pain is often present upon one side only.

Renal colic has been discussed on page 312 as an acute abdominal condition. The principal affections from which such an attack must be differentiated have also been referred to. These were appendicitis, intestinal obstruction, peritoneal adhesions, and gallstones. We must now consider the second question in the diagnosis of active cases.

FIG. 200.—SPECIMEN OF CALCULOUS PYELONEPHRITIS.

The specimen shows many calculi *in situ* both in the cortex and pelvis of kidney. Note the extensive destruction of the cortex through the suppurative condition following the presence of calculi.

This problem is to exclude all other conditions which might cause renal colic. There are three classes of cases which may give rise to renal colic. These are: (*a*) Those which produce obstruction of the ureter, such as floating kidney (kinking of ureter), pyonephrosis (plugging of ureter by pus), neoplasms (plugging by blood or tumor masses), tuberculosis (plugging by blood or caseous particles). (*b*) Those which produce colic without obstruction. These are acute congestion of one kidney, or acute exacerbations of a chronic nephritis, which has been shown to be quite often unilateral. (*c*) Colics due to diseases of the ureter, such as ureteritis, strictures, or pressure of tumors from without.

The majority of attacks of renal colic are due to calculi,[1] yet it is well to bear all of these other causes in mind in making a diagnosis. The accompanying symptoms of all of the affections mentioned will usually enable one by excluison to state that the attack was one of renal colic due to calculi. The symptom-complex commonly known as renal colic is

[1] By the word calculus one does not always mean a distinct stone, since it is well recognized that crystals of uric acid or calcium oxalate may cause colicky pain in their passage through the ureter.

characterized clinically by the more or less sudden onset of severe pain, either first felt over the lumbar region or radiating along the ureter toward the bladder, testis, penis, inner side of thigh, stomach, or bladder wall. In some, the pain is either referred to the opposite side or is located at a fixed point along the course of the ureter. In the latter class when the pain is upon the right side close to the brim of the pelvis, the clinical picture is quite similar to that of an acute catarrhal appendicitis.

In addition to these renal colics, the diagnosis can be made in these active cases from the same symptoms and objective findings as in the quiescent cases.

2. Diagnosis in the quiescent stage, *i. e.*, when no colics are present. These cases occur clinically in two forms:

(*a*) Those in which the symptoms are referred to other organs until a colic or hematuria occurs, *e. g.*, cases treated as floating kidney, cystitis, gallstones, chronic rheumatism, lumbago, intercostal neuralgia, dyspepsia, and uterine or adnexal disease.

(*b*) Those in which there are distinct symptoms referable to the kidneys, *e. g.*, pain, hematuria, passage of calculi.

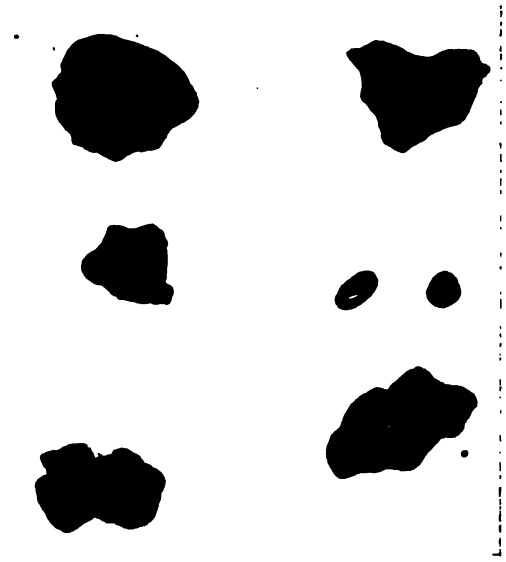


FIG. 261.—RENAL CALCULI AFTER REMOVAL FROM THE KIDNEY. These are the same as shown in Figs. 260 and 262. Note the variation in size and shape. The round ones, like gallstones of small sizes, can be passed spontaneously, but the irregular ones usually are lodged in one of the calices of the pelvis.

The symptoms of both forms may be one or more of the following:

Pain.—This is either of a continuous or of an intermittent, dull, aching character, referred to the lumbar region of the same or opposite side, or there is a sensation of weight or pressure. The pain is very commonly spontaneous, but is often increased by exertion, or the pains may occur at a certain hour.

Palpation.—Unless infection has occurred in a calculous kidney, or calculi are combined with a neoplasm or tuberculosis, no palpable enlargement of the kidney is found. According to Israel, such enlargement was found in twenty-two out of thirty cases, due either to septic infection or the result of lipomatous changes.

Tenderness of the affected kidney will often be complained of on bimanual palpation. This is most marked at the end of a long expiration. The pain is felt either along the ureter or in the bladder or penis, occasionally in the opposite kidney. The ureter is often tender, especially where it crosses the pelvic brim.

Urinary Changes.—Careful search of the urine will at some time show the presence of red corpuscles. There is also a trace of albumin in uncomplicated cases.

If infection of the kidney has occurred, pus is found in varying quantities. The presence of crystals of uric acid, etc., is of no value.

FIG. 262. SKIAGRAPH OF KIDNEY FILLED WITH CALCULI. (Specimen kindly lent by Dr. L. E. Schmidt.)

This picture was made by placing the extirpated kidney upon the x-ray plate. Note the branching character of the calculi, how they fill the calyces, also observe the large club-shaped end of one calculus obstructing the ureter.

Hematuria.—Blood in the urine is a most important symptom. The blood may only be found during the attack of renal colic or it may be present in small quantity constantly. In this connection it must not be forgotten that blood-corpuscles may be found in the urine during an attack of appendicitis. The mere presence of blood in the urine does not signify renal or ureteral calculi, since it may occur in tumors, in tuberculosis of the kidney or bladder, and in the so-called essential hematuria of the kidney, as well as in certain forms of nephritis, especially those of an interstitial type. The older tests which attempted to differentiate between vesical and renal sources of the blood by the condition of the red corpuscles, and by the fact that the blood appeared at a certain period of the act of urination, can no longer be relied on.

The use of the cystoscope is the most reliable mode of diagnosis, and will soon tell us in the majority of cases whether the blood is of vesical or renal origin.

The presence of blood in the urine, combined with the history of

renal colics or of long-continued pain in the lumbar region will, in the absence of a positive *x*-ray picture, only be suggestive of renal calculus, if other renal lesions, such as tuberculosis, tumors, pyonephrosis, and hydronephrosis, be excluded.

In calculus the hematuria is, in general, more dependent on exertion, while in tuberculosis and neoplasms this is not the case. Unless infection has occurred, the urine in tuberculosis is likely to contain both red corpuscles and pus, and in the latter there are tubercle bacilli. In nephritis there would be casts and a larger percentage of albumin. It is

FIG. 263.—BILATERAL RENAL CALCULI. (Case of Dr. Anna M. Braunwirth.)

Note the long shadow on the right side showing a calculus extending into the ureter. The two types of twelfth ribs are well shown by comparing Figs. 263 and 264. Note the short twelfth rib in Fig. 263 and the long twelfth rib in Fig. 264.

well to remember that both tuberculosis and tumor may be associated with calculi.

The characteristics of the urine in intermittent hydronephrosis have been referred to (page 357).

It is always best to collect the urine for twenty-four hours in every case of suspected renal calculi and examine a centrifugated specimen. One must also remember that the passage of uric acid or oxalate of lime crystals may cause red blood-corpuscles to be present in the urine.

x-Ray.—The use of the *x*-ray has been of the greatest aid in the diagnosis of renal and ureteral calculi. The majority of surgeons who have systematically employed it in their cases of suspected renal calculi

are agreed that with the proper technic shadows of calculi can be secured in nearly every case in which the symptoms point to their presence. Such an able and reliable surgeon as Kümmell, of Hamburg, believes that if calculi are present the diagnosis can invariably be made from the *x*-ray. In regard to the proper method of taking *x*-rays of renal calculi: In the first place, proper preparation is absolutely essential, especially in stout individuals. A brisk catharsis, followed by liquid diet during the

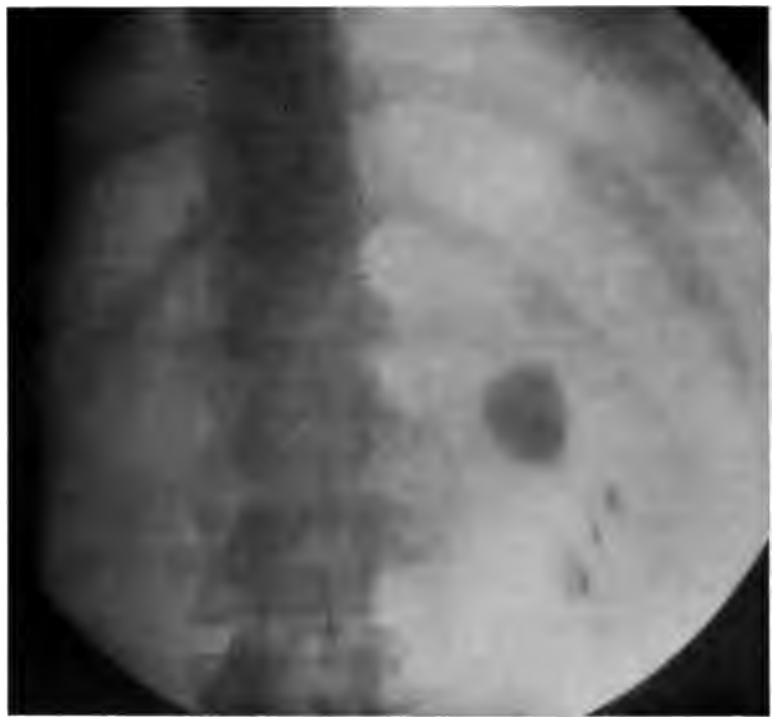


FIG. 264.—SKIAGRAPH OF RENAL CALCULI.

This skiagraph reveals the calculi present in the right kidney of a case of bilateral calculi. The calculi of the left side had been removed. The diagnosis of bilateral calculi had been made from skiagraphs before the operation for the removal of calculi from the left or opposite kidney.

twenty-four hours preceding the exposure, will clear the bowels of any substances which are apt to give shadows. Secondly, the lumbar region should be brought as close to the plate as possible by raising the shoulders and thighs so as to overcome the normal lordosis of the spine as much as possible. Third, a soft tube is a requisite aid. Fourth, if one wishes to be exact, a first, diffuse exposure of both kidneys and ureters should be made without the use of any special apparatus.

The recent rapid progress in the skiagraphy of renal and ureteral calculi has been due to the use of the Albers-Shoenberg compression apparatus, which cuts off all Roentgen rays except over a small area, and gives a much sharper but smaller picture.

One should never omit taking such a compression *x*-ray of each kidney separately, and if possible of each ureter. *The number of cases, to the present date, of bilateral calculi is sufficiently numerous to require x-rays of both kidneys in every case.* In order to consider a renal skiagraph of value the last two ribs, transverse processes of the last dorsal and lumbar vertebræ, and psoas muscle must be quite sharply outlined.

In the case of renal calculi one must exclude shadows due to the following conditions:[1] (*a*) Tumors or dilated calyces. These show as poorly demarcated shadows. (*b*) Scybala. These are round, delicate, poorly outlined, and darker in the center. If there is any doubt, it is best to give a purgative and take another picture. (*c*) Foreign bodies in the intestine. (*d*) Calcified retroperitoneal lymph-nodes. (*e*) Centers of ossification in the lower costal cartilages.

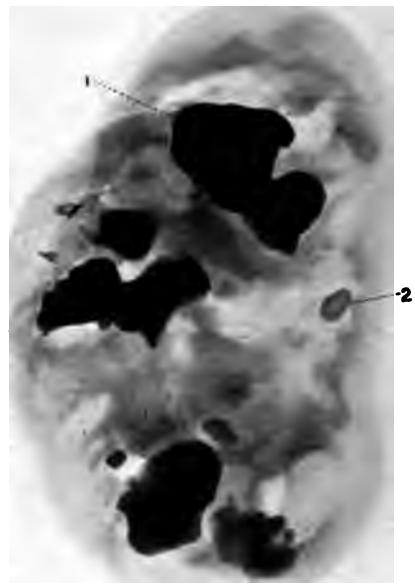


FIG. 265.—X-RAY OF A KIDNEY REMOVED ON ACCOUNT OF EXTENSIVE DESTRUCTION, DUE TO CALCULOUS PYELONEPHRITIS.

The illustration was made by taking the kidney after it was extirpated and laying it upon an *x*-ray plate and then exposing it to the tube. 1, Renal calculus which casts an intense shadow; 2, small calculus which throws very slight shadow.

Pure uric acid calculi cast the faintest, and oxalates and phosphatic stones the most marked, shadows. One can tell fairly accurately from the position and size of the shadow whether the calculus is large or small, whether it is in the pelvis or in a dilated calyx, and at times one can tell whether the calculus lies free in a large cavity, by the change in its position during different exposures.

A kidney may contain numerous calculi and yet only one or two will

[1] See article of Holzknecht and Kienbock, "Zeitschrift für Urologie," No. 5, vol. ii.

give a shadow (Fig. 264). In the case of ureteral stones, where the error is most likely to occur, this can be eliminated by taking a picture before and after passing a metal ureteral bougie. The fact that calculi may be present in both kidneys is now well established. In a recent article Kümmell[1] reports the occurrence of renal calculi upon both sides in 16 of 101 cases, *i. e.*, nearly 16 per cent. Israel estimates that bilateral calculi occurred in 27 per cent. of his cases.

FIG. 266.—SPECIMEN OF DOUBLE URETER FORMATION.

RK, Right kidney; LK, left kidney. 1, Right ureter; 2 and 3, represent the separate ureters present upon the left side; 4, rudimentary uterus; 5, bladder.

ANURIA.

Anuria[2] may be defined as a condition in which no urine reaches the bladder. There are two chief varieties: (*a*) a false anuria, in which no urine can enter the bladder owing to some obstruction in the ureters; and (*b*) a true renal anuria, in which the kidneys fail to secrete any urine.

1. *False or Anuria in the Wider Sense.*—This is the result of closure of both ureters by calculi, tumors of the pelvis, ovaries, uterus, etc. The most frequent cause is a calculus obstructing the ureter, as shown in Fig. 267. The kidney continues to secrete, but back pressure of the stagnant urine produces a dilatation of the pelvis, followed later by a uronephrosis as the result of pressure atrophy of the parenchyma. If both ureters are obstructed by calculi, or only one side is obstructed and the opposite kidney is in a condition known as hypoplasia (Fig. 267), due to lack of development, anuria will also follow:

2. *True or Renal Anuria.*—In cases of anuria in which the possibility of ureteral obstruction by one of the above mentioned causes has been ex-

[1] "Zeitschrift für Urologie," Nos. 3 and 4, 1908.

[2] Kümmell, "Zeitschrift für Urologie," No. 12, 1908.

cluded by the history of the case, *x*-ray examination, etc., one must consider a complete cessation of renal function as the cause of the anuria. Such renal causes are:

(*a*) Diffuse nephritis (due to chronic interstitial and parenchymatous nephritis, toxic nephritis, and the various forms of nephritis following the acute infectious diseases).

(*b*) Tumors of both kidneys (cystic kidneys, hydronephrosis, malignant neoplasms).

(*c*) Disease of one kidney (tumors, hydronephrosis, nephritis, injury, etc.) associated with congenital or acquired defect of the opposite one (Fig. 267).

(*d*) Reflex anuria. This is the result of a reflex action which causes a previously healthy kidney to be suddenly inhibited, so that it ceases to secrete through the nervous influence exerted by the opposite kidney. The function of the latter has been previously arrested, as the result either of obstruction of the ureter, hydronehprosis, tuberculosis, trauma, or tumors, or of its having been removed by the operation of nephrectomy. Such a reflex anuria seldom occurs when the opposite kidney is healthy. Attention has been frequently called in these pages to the necessity of determining not only the presence, but also the functional capacity, of the opposite kidney before performing a nephrectomy.

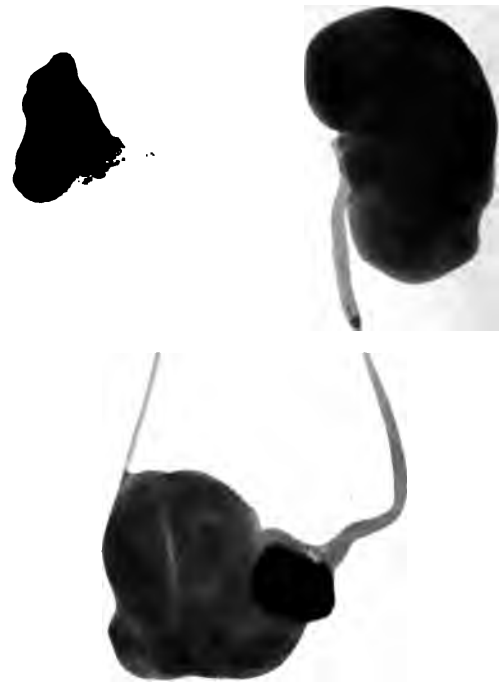


FIG. 267.—SKIAGRAPH OBTAINED BY PLACING SPECIMEN SHOWN IN FIG. 268 UPON AN *X*-RAY PLATE.

The various locations of the ureteral calculi are well shown, and the calculus located at the middle of the ureter is conical, its pointed end projecting into the stricture. Several calculi are seen in the parenchyma of the right kidney. The faceted matter of the lower ureteral calculus is well shown.

URETERAL CALCULI.

Ureteral calculi almost invariably come from the kidney (called secondary stones). The three points where calculi are apt to become

lodged are: (1) one and a half inches below pelvis of kidney; (2) one to two inches below pelvic brim; (3) in vesical portion. The majority are, however, lodged below the iliac vessels, *i. e.*, the portion between the pelvic brim and the bladder. Ureteral calculi may be of any size or shape. In the majority of the reported cases only one stone was found, but there may be as high as twenty-four. A calculus may remain impacted for years without symptoms. In many cases, however, the ureter may become ulcerated and thickened. The ureter may be perforated by the stone or it may perforate into the rectum or bladder. The ureter above the stone is usually dilated. The most serious changes resulting from ureteral calculi occur in the kidney. A complete obstruction causes an atrophy, with complete loss of function. An incomplete obstruction produces hydronephrosis, which is very apt to be converted into a pyonephrosis. A complete anuria may result from the lodgment of a ureteral calculus.

Diagnosis of Ureteral Calculi.—Aside from the *x*-ray, it is impossible to differentiate between renal and ureteral calculi. There is usually a history of repeated attacks of colic.

Pain.—In the upper portion of the ureter the pain resembles that of vesical calculus. When the stone is in the lower portion of the ureter, the pain is very apt to be referred to the bladder, penis, or testicle. Frequent tenesmus and micturition are common. Localized tenderness is of great aid when found after the subsidence of the colic. It is apt to be much more localized and fixed and persistent than the pain due to an inflamed appendix. Where there is a renal colic associated with marked vesical symptoms, a calculus in the lower portion of the ureter should always be suspected. As a rule, the stone can be felt by rectal or vaginal examination, if within two inches of the bladder.

Hematuria.—This sign, when accompanied by other symptoms, and especially when persistent, is of significance. Blood found by microscopic examination is of great value when the urine has been passed without the catheter.

Polyuria, Oliguria, and Anuria.—Polyuria following an attack of pain, especially if it has been preceded by an oliguria during the pain, is of great aid in making a diagnosis. The urine which has accumulated behind the calculus suddenly escapes after the attack. Complete anuria following a renal colic is almost pathognomonic (see page 428) of ureteral calculus.

Cystoscopy.—The cystoscopic examination may reveal a calculus, projecting into the bladder. Wax tipped bougies passed into the ureter are of doubtful value in the diagnosis of ureteral calculi.

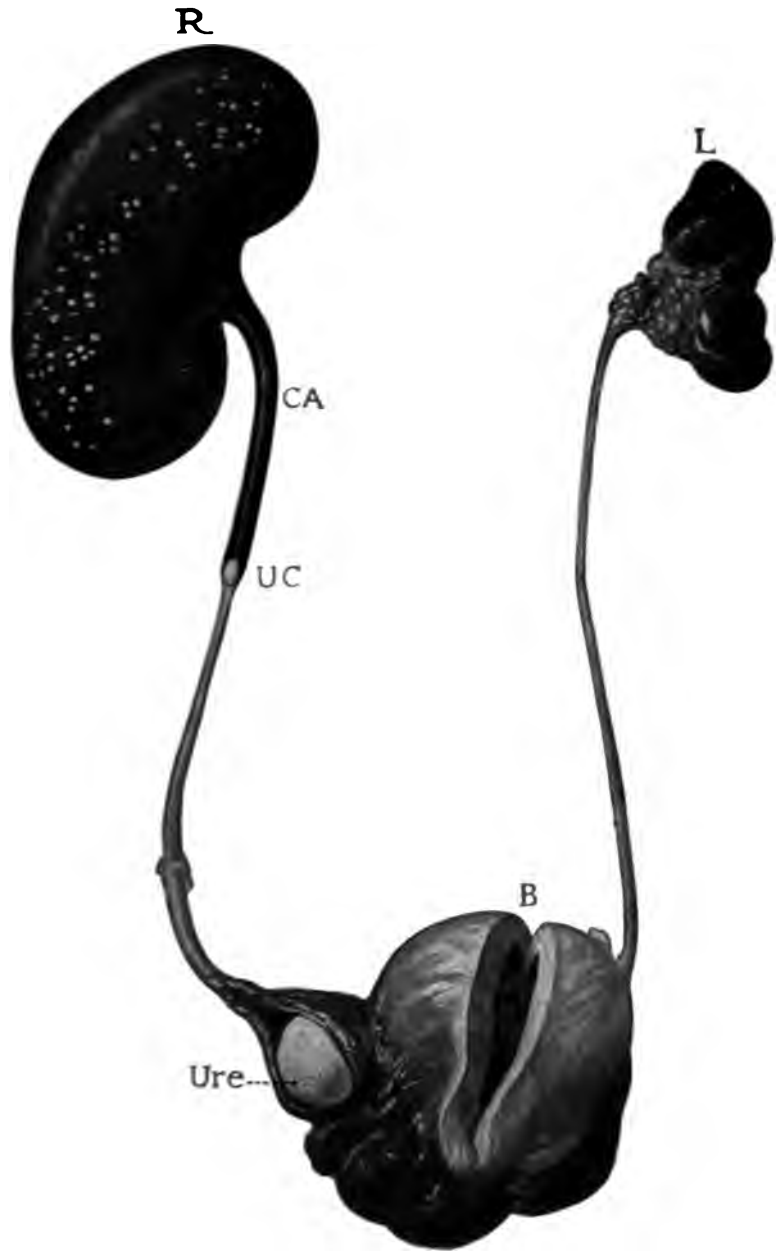


FIG. 268.—SPECIMEN REMOVED AT AUTOPSY SHOWING MULTIPLE CALCULI IN RIGHT URETER (Eisendrath and Herzog).

R, Greatly enlarged right kidney showing evidences of suppurative pyelonephritis; CA, right ureter distended with blood and urine; UC, ureteral calculus located just above a stricture of the ureter; Ure, large faceted ureteral calculus located in distended vesical end of the ureter; B, bladder opened in median line; L, undeveloped left kidney showing fetal lobulations.

x-Ray.—Unless the calculi are of the uric acid variety, the *x*-ray will certainly give a positive result if a calculus be present. The details for taking such pictures by the compression apparatus have been described on page 425. Other substances giving shadows which are confused with ureteral calculi are calcareous deposits in muscles, blood-vessels, or pelvic ligaments, phlebolitis, etc. These can be excluded by passing a soft flexible wire probe (Fig. 566) into a previously introduced ureteral catheter.

FIG. 269.—VIEW OF ECTOPIA VESICÆ IN SAME PATIENT SHOWN IN FIG. 270.
H, Congenital hernia; *V*, prolapsed posterior wall of bladder; *E*, epispadias.

THE BLADDER.

CONGENITAL MALFORMATIONS.

Ectopia Vesicæ or Exstrophy of the Bladder.—The most frequent form is the one in which the entire anterior wall of the bladder and the abdominal wall over it are not present.

The posterior wall of the bladder presents itself as a red, easily bleeding mass which protrudes beyond the level of the surrounding skin (Fig. 269). Associated with it are usually found a non-union of the pubic bones, a lack of development and deformity (epispadias) of the penis, and a congenital hernia (Fig. 269).

The condition can be readily recognized by the red protrusion above

the pubis, from which urine constantly escapes, causing irritation of the surrounding skin.

To prove the nature of the protrusion, one can lift it up a little and watch the jet of urine escape from the ureteral papillæ and pass fine catheters or probes into these (Fig. 270).

The deformity is more often present in females than in males.

URETHRAL OR CATHETER FEVER.

The passage of a sound or catheter is at times followed by sudden high temperatures from 101° to 109° F. In some of the cases the high fever, rapid pulse, and rapid respirations will be followed by death soon after the passage of the instrument into the urethra or bladder. These cases are often devoid of any obstruction in the urethra such as a stricture or foreign body. In addition to the cases in which high fever, etc., occurs, there are others in whom such instrumentation is followed by suppression of urine. The urethral fever may be preceded or followed by a chill and profuse perspiration. Some writers object to the term "catheter fever," since repeated chills and high temperatures may occur where there is obstruction and infection, even without the passage of instruments. There can be no doubt that there are cases in which there is neither infection nor obstruction, but only retention present, and that the chills and high fever following the passage of sounds, catheters, etc., can only be explained as a form of urethral shock due to profound irritation of the thermogenic centers from a center in the deep urethra.

WOUNDS OF THE BLADDER.

The diagnosis of these has been described in connection with injuries of the abdominal viscera in general (page 259).

INFLAMMATION OF THE BLADDER.

Cystitis.—Clinically, the division of cystitis into the acute and chronic forms is the most convenient.

Acute Cystitis.—The most important symptoms from which a diagnosis is made are:

1. *Painful, Increased Frequency and Urgency of Urination.*—The urine is voided at shorter intervals than normal. The patient has the feeling of being obliged to pass the urine immediately after the desire is felt (urgency of micturition). The pain increases with each urination, and the act itself is followed by marked vesical tenesmus, so that the patient

in severe cases has an almost constant desire to urinate. Complete retention may occur, only the overflow being involuntarily voided.

2. *Tenderness and Pain.*—This is often quite marked in the hypogastric region and perineum. If the cystitis is due to stone, the pain is most severe at the end of urination.

3. *The Urine.*—The urine may be acid or alkaline in the acute cases, but becomes alkaline in the chronic cases. The urine is turbid owing to the presence of large amounts of pus-corpuscles. The more alkaline

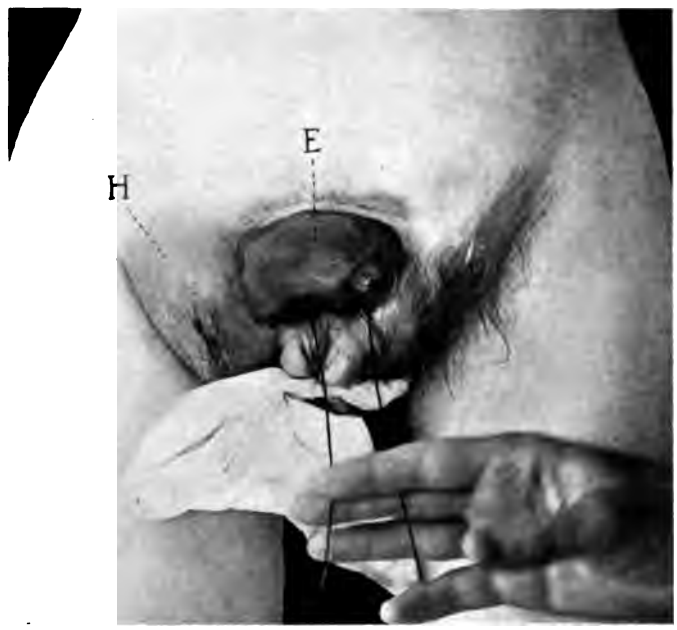


FIG. 270.—ECTOPIA VESICÆ ACCOMPANIED BY EPISPADIAS AND CONGENITAL RIGHT-SIDED HERNIA.

E, Epispadias. Posterior wall of the bladder is seen prolapsed through the hiatus in abdominal walls H, Congenital right-sided inguinal hernia. Two catheters are shown passing into the left and right ureter respectively. The orifices of the ureters are situated close to the junction of the lower border of the prolapsed bladder with the abdominal wall.

the reaction, the more marked is the ammoniacal odor and the larger the number of triple phosphates and quantity of mucus present.

4. *General Symptoms.*—There is usually a moderate rise of temperature with anorexia and sleeplessness. In some cases the disease is ushered in by a chill followed by a rise of temperature of varying intensity and with irregular exacerbations.

In *diphtheritic cystitis* all of the above symptoms are more marked, especially the pain and ammoniacal urine. The fever runs a course

like a typhoid and there are signs of severe sepsis, such as delirium, sweats, and rapid pulse.

Chronic Cystitis.—This arises either from the acute variety or begins as a subacute process which becomes a chronic one.

The symptoms are all less marked than in the acute cases. Pain is but slight and often consists only of a mild burning sensation on urinating. The increased frequency and urgency of micturition are quite marked, especially after exposure to cold or errors in diet.

After the urine has been passed there is always some residual urine, since the disease is most common where some obstruction exists, such as prostatic hypertrophy or stricture of the urethra in men or prolapse of the uterus in women. In those cases which follow an acute cystitis, this residual urine symptom is seldom present. The frequent desire to urinate is especially marked at night.

The urine is usually alkaline in reaction, containing much pus, epithelial cells, and triple phosphates.

The *complications of acute cystitis* are a gangrene of the bladder wall, causing pyemia and death, or the ulceration which may rarely go on to perforation or peritonitis, or an acute pyelonephritis (page 278).

The *complications of chronic cystitis* are:

(*a*) A pyelitis or pyelonephritis.

(*b*) The formation of abscesses in the bladder wall or of a perivesical phlegmon in front of or behind the organ.

(*c*) The perforation of the diverticula which often form in these cases, causing peritonitis or prevesical abscess (page 251).

(*d*) A chronic condition of septic intoxication called ***urosepsis***, from the absorption of toxic products from the decomposing urine. The signs of this are frequently recurring chills followed by profuse sweats and rise of temperature, vomiting, delirium, and a gradual loss in weight.

Differential Diagnosis of Cystitis.—*Renal Suppuration.*—Although there are bladder symptoms, these appear and disappear without any special cause, while the quantity of pus remains constant and is greater than in a cystitis. The only accurate method to determine whether a pyuria is of vesical or renal origin is by a cystoscopic examination.

Posterior Urethritis or Prostatitis.—In both of these conditions, as in acute cystitis, there is increased frequency of and painful micturition. The other differential diagnostic points are given on page 444.

SIMPLE ULCER OF THE BLADDER.

This condition is similar in origin to the round ulcer of the stomach. It is not as rare as generally believed. Walker[1] states that the three prominent symptoms are increased frequency of micturition, pain in the penile portion of the urethra, and hematuria. The diagnosis is only possible by the use of the cystoscope. The ulcer has a punched-out appearance with clean and smoothly cut edges. Its edges are more regular in the early stages than are those of a tuberculous ulcer. There is no undermining of the edges, as in the tuberculous ulcer, and no evidence of tuberculosis elsewhere.

TUBERCULOSIS OF THE BLADDER.

This condition is secondary to the same affection in the kidneys in both sexes, or in the male may, in addition, be secondary to a primary focus in the testis with resultant ascending infection. A primary tuberculosis of the bladder is very rare. If the infection is an ascending one (testis, etc.), the lesions are found at the trigonum. If the infection had its origin in the kidney, the lesions are found in the vicinity of the ureteral orifice of the same side.

A hematuria may often be the first symptom, followed by painful and increased frequency of micturition. The blood is passed in large clots and is not intimately mixed with the urine, as it would be in a renal hematuria. In other cases the vesical tuberculosis develops in a latent manner as a complication of a gonorrheal cystitis and shows itself by the constant presence of red blood-cells in the urine. The urine in the early stages is acid and there is but little pus; later it is alkaline and there is considerable pus and mucus. Tubercle bacilli may be found in centrifugated specimens if a large quantity of fresh urine is used, or some of the pus is injected into a guinea-pig.

The diagnosis is easy if the above symptoms are found in a person who has a primary focus of tuberculosis elsewhere.

Every pyuria or hematuria occurring in young persons without any apparent cause should lead to the suspicion of a vesical or renal tuberculosis. Hematuria due to cancer occurs at an older period, while that due to renal calculi usually ceases when the patient is kept quiet, while rest has no influence on the hematuria of tuberculosis.

By the aid of the cystoscope one can detect ulcerations at the orifices of the ureters and the neck of the bladder. These tuberculous ulcers are rounded, tend to coalesce, and their edges are often undermined. Their

[1] "Journal of the American Medical Assoc.," March 23, 1907.

floor is uneven and covered with a dirty grayish membrane and bleed easily. The presence of renal symptoms and the escape of pus from the corresponding ureter, as determined by cystoscopic examination and ureteral catheterization, help to confirm the diagnosis. The crucial test, however, is the discovery of tubercle bacilli either by staining or the guinea-pig inoculation test.

HEMATURIA.

It is more interesting than practical to discuss the various sources of hematuria and pyuria. The crucial test in both cases as to the cause is a cystoscopic examination. Davis[1] has suggested the following classification of the causes of vesical hematuria:

1. Circulatory disturbances, such as varicosities of the prostatic veins or passive congestion from any cause.

2. Trauma, such as rough passage of instruments, foreign bodies such as calculi, contusion, or rupture of the bladder.

3. Infection. Tuberculous and other forms of infection are frequent causes of hematuria. It may only be microscopic. In tropical countries other causes are the parasites, filaria, and distoma.

4. Neoplasms. Papilloma and carcinoma give rise to the most severe and persistent bleeding. It occurs independently of exercise and either by day or at night.

In addition to the above vesical causes, one must consider renal sources, such as tumor, tuberculosis calculi, etc.

VESICAL CALCULI.

The characteristic symptoms of stone in the bladder are pain, hemorrhage, and disturbances of micturition. These are very frequently combined with the symptoms of chronic cystitis, or of hypertrophy of the prostate, so that the clinical picture becomes a complex one.

(*a*) The pain is felt in the end of the penis, especially toward the end of urination, or the pain may be felt at the neck of the bladder, especially upon exertion or sudden jarring of the body. The pains may radiate to the rectum, testis, or thigh.

If the calculus is pointed and becomes fixed in the meatus internus, the pain is often excruciating, and is increased by each vesical contraction.

(*b*) Micturition is seldom normal. There is usually increased frequency. If the stone is small, the stream is often suddenly interrupted. In some cases there is enuresis, in others retention of urine, especially if

[1] "Annals of Surgery," 1906.

the calculus becomes wedged in the internal meatus. Obstinate enuresis and straining while urinating are often the first signs in children.

(*c*) Condition of the urine. This contains pus and mucus, varying according to the degree of cystitis which is present. Blood in small quantities is often mixed with the urine, especially after any exertion. One specimen may contain blood and the next be perfectly clear. In general, the hematuria is never as marked nor as continuous as in neoplasms or tuberculosis, unless the latter coexist and has a direct relation to exercise.

In children, prolapse of the rectum and straining at stool or in urination, or the presence of herniæ, should always lead to the suspicion of calculi. The history of a previous renal colic may be of great value. The diagnosis of vesical calculus can be confirmed by one or more of the three following methods of examination:

(1) The use of a specially constructed sound called a "stone searcher." This should be of 12 to 15 French size, and have a rounded, blunt end. The beak is short and forms an angle of 120 degrees with the shaft.

The bladder should contain two ounces of fluid in children and four to six ounces in adults, the organ having been previously irrigated with boric acid solution through a soft-rubber catheter. Some 2 per cent. eucain solution is injected into the deep urethra. If the bladder is very sensitive or the deep urethra is very rigid on account of an enlarged prostate a general anesthetic should be given. If the urine is ammoniacal, the examination should be preceded for a few days to a week, if possible, by daily irrigations and the internal use of urinary antiseptics. The bladder should be systematically explored the beak being rotated in all directions. The horizontal position with elevation of the pelvis is best suited for these cases.

If the prostate is enlarged, the handle of the sound is raised. When the sound strikes a stone, there is a sharp metallic click. A stone which is hidden in a diverticulum or deeply in the retroprostatic pouch is often found with great difficulty. The former may be suspected if the sound only strikes it in one position and cannot be made to pass around the calculus.

(2) Cystoscopic examination. This is an almost infallible method, and is especially valuable in the case of calculi which lie in diverticula, or for foreign bodies in the bladder. Its use may be very difficult if there is much cystitis or a marked prostatic hypertrophy.

(3) Skiagraphic examination. This method has been used considerably since the introduction of the *x*-ray. As in the case of renal calculi, phosphatic, oxalate, and cystin stones give deep, while urate and uric acid calculi only cause light shadows. The [redacted] if the

result is a positive one. No reliance can be placed upon a negative picture. The best method is to employ a compression apparatus, as in renal skiagraphy (page 426).

TUMORS OF THE BLADDER.

These are divided clinically into the benign and malignant. The best classification is that of Küster: (1) Epithelial group (papilloma, carcinoma, adenoma, and dermoid cysts); (2) connective-tissue group (sarcoma, myxoma, fibroma, and angioma); (3) muscular group (myoma). Sarcomata occur in children and grow rapidly. Papillomata appear in middle life, while carcinomata grow slowly and appear in elderly people. The majority of the former are papillomata, made up of long pedicles or sessile, warty tumors with a broad base. They may be single or multiple and are most often situated near the trigone, and not infrequently recur after removal or become malignant in character. Of the malignant, the majority are primary either in the prostate or in one of the neighboring structures (rectum, uterus, etc.). The diagnosis of a vesical neoplasm may be made from the presence of (*a*) sudden hematuria occurring without apparent cause and which is not renal in origin, accompanied by pain and disturbances of micturition, and (*b*) the results of the examination of the urine, and of cystoscopic and rectal examination.

(*a*) The hematuria may be the first symptom, as it is of other renal and vesical conditions (calculi and tuberculosis). In tumors it is the first sign in the majority of cases. If the blood comes from the kidney it is intimately mixed with the urine, has been accompanied by colic, and there are often worm-like coagula. In hemorrhage from the urethra the liquid or clotted blood precedes the voiding of urine. In bladder hemorrhages the first urine contains but little blood, but the amount is gradually increased until pure blood is evacuated. The cystoscope is the only reliable method of determining the source of the hematuria.

The hematuria from benign tumors is often intermittent, occurring without any cause, is not increased by exertion, and is bright red. In malignant growths the hemorrhage is more apt to be persistent and smaller in amount.

Frequency and urgency of micturition are generally absent in smaller benign and malignant growths. In larger ones there is often great difficulty in micturition and even retention of urine.

Pain is generally absent in papillomata and is not marked in the carcinomata until the infiltration is extensive or the bladder becomes infected. It is then not only present during, but also between, urination.

The discovery of some of the villi of a papilloma is one of the most positive signs, but these are not often found. In the malignant tumors which are primary in the prostate, rectal examination will show a much harder, stone-like enlargement of the gland than is the case in ordinary hypertrophy. In a recent case the writer was led to suspect a malignant prostate from the palpation of very firm lymph-nodes in both inguinal regions of a cachectic man who had bladder symptoms. Rectal examination revealed, in addition to the hard prostate, a stricture of the rectum due to the extension of the growth around the rectum.

In a recent article on cancer of the prostate, Young [1] calls attention to this stony induration, as well as to a similar condition of the seminal vesicles.

Cystoscopic examination is of great value. It is very difficult to examine the bladder in cases of villous tumor, owing to the hemorrhage, but if this latter is not too great, the view obtained easily confirms the diagnosis.

In malignant tumors without marked projection above the level of the bladder wall, the diagnosis with the cystoscope is very difficult, but even in these cases it is often confirmatory, especially in cancer of the prostate which has invaded the trigone.

Wherever there is any doubt as to the nature of the tumor an exploratory suprapubic cystotomy is advisable in order that an early diagnosis may be made.

AFFECTIONS OF THE PROSTATE.

ENLARGEMENT OF THE PROSTATE.

Increased frequency of urination, often first noticed at night, in a man above forty, directs attention to the bladder and prostate. There is not only a desire to urinate more frequently, but a feeling that it must be passed immediately. The act requires longer than usual, and the stream lacks the force of a normal individual.

Retention of urine may begin gradually, the patient being able to pass less and less. It often begins suddenly after exposure to cold, debauches, or voluntary retention of the urine for a long period.

Pain is not a symptom of this condition until a cystitis has begun.

Hematuria may at times be very profuse from the varicose prostatic veins around the neck of the bladder. With the above history one can usually confirm the diagnosis by a systematic objective examination.

This should include:

[1] [illegible] Hopkins Hospital Bulletin," October, 1905.

1. Palpation of the prostate through the rectum to determine the extent of the enlargement in this direction, whether one or both of the lateral lobes are involved, and the consistency and nature of the enlargement. A fibrous prostate is but little enlarged and is very firm and fixed. An adenomatous prostate is larger, softer, and more movable.

2. Combined examination by the use of a metal or a special prostatic (Mercier) catheter inserted into the bladder, while the index-finger is introduced into the rectum. In passing the catheter the following points, according to Deaver, favor the diagnosis of enlarged prostate. (*a*) Undue depression of the shaft is necessary before the catheter enters the bladder. (*b*) The length of the urethra, *i. e.*, before urine comes, is more than eight inches. (*c*) The catheter is deviated to one or the other side by the unequal lateral lobes. (*d*) If an obstruction is encountered at a distance of more than seven inches from the external meatus, showing that the obstruction is not due to strictures which never occur in the prostratic urethra.

3. Determination of the amount of residual urine by allowing the patient to evacuate the bladder and then inserting either a metal or a special prostatic catheter, known as the Mercier, with a short beak, and allowing the residual urine to escape.

4. A thorough examination of both the quantity of urine passed in twenty-four hours and its constituency.

5. By rotating the metal catheter around in the bladder gently, one can gain an idea of whether it is dilated or contracted, and also whether any calculi exist. A contracted bladder accompanies a fibrous, a dilated an adenomatous prostate.

6. The cystoscope is of great confirmatory value if it can be used, although this may be very difficult.

Differential Diagnosis.—*Cancer of the Prostate.*—The induration of the enlargement as palpated per rectum is more stony and involves the seminal vesicles at an early period in a similar induration.

There is often early, sharp, shooting pain along the inner side of the thighs or along the sciatic nerves. It also causes early cachexia, and cystoscopic examinations fail to detect much enlargement toward the bladder unless a previous benign enlargement has existed. The inguinal glands are also of stony hardness and enlarged. *Sarcomata* are very rare and grow very rapidly.

Polyps of the Bladder (*Fibrous*).—These are quite rare and cause obstruction symptoms like an enlarged middle lobe. Rectal palpation usually shows an absence of enlargement of the prostate. The

frequency of hematuria and a cystoscopic examination will aid in distinguishing it.

Tuberculosis of the Prostate.—This may cause enlargement of, and the formation of nodules in, the prostate. The disease is rarely primary. The diagnosis may usually be made from the presence of the same disease in the epididymis and the fact that it generally occurs at an earlier age than prostatic hypertrophy.

The diagnosis of carcinoma of the prostate has been considered on page 439, while that of tuberculosis of the prostate will be referred to in connection with the same disease in the male productive organs (page 417). Inflammations of the prostate are discussed in connection with their most frequent etiologic factor, viz., gonorrhea (page 443).

INJURIES AND DISEASES OF THE URETHRA AND PENIS.

CONGENITAL MALFORMATIONS.

Epispadias and Hypospadias.—Both of these deformities can be readily diagnosed. In *epispadias* there in an imperfect formation of the upper wall of the urethra (Fig. 269). There are three forms: (*a*) One in which only the glans penis is involved. This is so rare that only three genuine cases have been described. (*b*) The groove extends back to the middle of the penis. (*c*) The most frequent form. This form is usually associated with an ectopia of the bladder and a defect in the pubic symphysis (Fig. 270). The penis and the groove on its upper surface are very short and pass directly over into the bladder defect. *Hypospadias* is much more frequent than epispadias. The deformity is due to a defective formation of the lower wall of the urethra. There are also three forms: (*a*) The gap or groove involves only the glans penis (hypospadia glandis). (*b*) The groove extends back as far as the beginning of the scrotum. The urethral orifice is at the latter point. This form is less frequent than the first named and is called the penoscrotal form. The penis is usually curved down and laterally. (*c*) The scrotum is more or less completely divided into two lateral halves. The urethral opening is in the perineum or in the groove between the divided scrotum (perineoscrotal form). The penis is very short and bent downward and the foreskin, as in the penoscrotal form, shows a wide gap.

CONTUSION AND RUPTURE OF THE URETHRA.

This condition usually follows a fall upon some object like a plank or an axle, these coming in direct contact with the perineum. It may also follow a blow or kick in the same region, or the perineum may be torn

as a result of a fracture of the pelvis. The urethra at the bulbomembranous junction is caught between the unyielding pubic symphysis and the object upon which the patient falls. For this reason the tears are most often located at this point.

The probability of a rupture of the urethra must be thought of in every case either of blunt force applied to the perineum, or an injury in which the pelvis is crushed.

The cardinal signs from which a diagnosis can usually be made are:

1. The appearance of a hematoma or of a swelling in the perineum.

2. The escape of blood from the meatus either with or independently of urination. If it occurs with the latter, blood escapes before urine begins to flow.

3. There is either retention of or great difficulty in urinating and the act is accompanied by great pain in the perineum and at the end of the penis. The urine contains coagulated and fluid blood.

4. Urinary infiltration of the subcutaneous tissues, penis, scrotum, and anterior abdominal wall. This causes marked swellings, redness, and tenderness of the corresponding parts, and may be followed by severe septic infection or even gangrene. Such extravasation may occur immediately after the accident or gradually in the course of a few days. In the milder cases of rupture of the urethra there is but little bleeding from the meatus, the urine is almost clear, and there is only a slight amount of perineal swelling.

FIG. 271.—ENORMOUS ELEPHANTIASIS OF THE SCROTUM, FOLLOWING TRAUMATIC RUPTURE OF THE URETHRA.

This is the front view of the patient shown in Fig. 269.

The diagnosis of the more severe forms depends upon the observation of the large amount of blood from the meatus, the perineal hematoma, the difficult and painful micturition, and at times the urinary infiltration with accompanying sepsis.

Traumatic rupture of the urethra may be followed by strictures and perineal fistulæ (Fig. 272), whose diagnosis is the same as that of the same conditions when due to gonorrhea (page 446). If a patient gives the history of a fall followed by difficulty of urination, one must always

think of a stricture. When a tear of the urethra coexists with a rupture of the bladder and fracture of the pelvis, as in one of my cases, the diagnosis is very difficult, but can usually be made by a careful study of the physical findings.

LOCALIZATION OF PUS IN THE LOWER PORTION OF THE MALE GENITO-URINARY TRACT (FIG. 281).

The question whether pus and detritus, causing the urine to be turbid, originate in the anterior or posterior urethra or in the appendages of the lower urinary tract can be answered in one of the following ways:

FIG. 272.—POSTERIOR VIEW OF PATIENT SHOWN IN FIG. 270. SUFFERING FROM ENORMOUS ELEPHANTIASIS OF SCROTUM.

F, Opening of perineal fistula, which resulted from traumatic rupture of urethra and stricture subsequent to same.

The Two-glass Test.—After a patient has held his urine for some considerable time—two to four hours—he is advised to empty some of the urine into one glass, then to stop and to void the balance of the urine into another glass (Thompson test).

In a general way it can then be stated that, if only the first portion is turbid or shows floating shreds or flakes, the pus comes from the anterior urethra alone. If both portions are turbid or contain shreds or flakes, the posterior urethra is necessarily involved in the inflammatory process. Pus production in acute gonorrhea is usually so profuse that the first and second portions will be rendered turbid even if the affection is located in the anterior urethra only. The reason for this is that the posterior urethra does not permit the accumulation of any considerable amount of secretion in its lumen. At the very moment that secretion accumulates, it flows back into the bladder. In this way the secretion becomes mixed with the urine contained in the bladder.

[redacted] voided flushes out the anterior urethra,

carrying off the adherent pathologic products. Unless secretion flows back from the posterior urethra into the bladder, the second portion of urine will appear clear. The conclusion to be drawn from this rather crude test must be subjected to the following criticism:

A very thick secretion originating in the anterior urethra may still adhere to the mucous membrane after the first portion of urine has passed. Thus the second portion may also contain flakes of pus that originate in the anterior urethra. Again, at the time of the test there may be very little production of pus in the posterior urethra, so that the second portion of the urine appears clear, although there is still disease in the posterior urethra. The two-glass test is only of value if it is employed repeatedly and at different visits.

The principle of this test can be applied in a more refined manner in the following way: The test is best made early in the day. After the patient has retained his urine for some considerable time, the anterior urethra is washed out with sterile water, either by using a soft-rubber catheter whose tip does not reach beyond the spongy portion of the urethra or by applying a Valentine nozzle without overcoming the resistance of the compressor urethræ. This flushing is continued until the returning fluid appears to be absolutely clear. Then the urine is voided; all impurities contained in this specimen necessarily come out of the posterior part of the urethra.

Another valuable addition to this method is as follows: If it is desirable to gather information as to the question whether secretion comes from the prostate or the seminal vesicles, the anterior urethra is first flushed out in the manner described above. The patient should then pass half of the contents of his bladder. The index-finger is now introduced into the rectum, and the prostate and the seminal vesicles are milked, and the patient then voids the balance of his urine.

The flushing liquid used for the irrigation of the anterior urethra contains the pathologic products of this portion. The first portion of the urine voided contains the products of the posterior urethra. The second portion of the urine voided contains the contents of the prostate and of the seminal vesicles. Pathologic products squeezed out of the seminal vesicles have a characteristic serpentine or twisted shape.

In very chronic cases, which show scant secretion, some additional means must be employed in order to find the seat of pathologic products.

In order to stimulate secretion for twenty-four hours previously to executing the test, irritating irrigations of the entire urethra are administered—1 to 10,000 bichlorid solution or 1 to 5,000 silver nitrate solution.

At the same time the patient is advised to drink some alcoholic

beverage the evening before the examination, such as beer or champagne. The pathologic products from infiltrated portions of the urethra are collected by first introducing an olive-tipped sound; all the places at which the sound shows some engagement are squeezed out over the olive tip by two fingers massaging the urethra from the outside.

The resulting discharge is treated in the manner above described. While it is easy and simple to examine specimens of the discharge microscopically as to their structure, the search for gonococci, particularly in chronic cases, not only calls for frequent examinations of numerous specimens, but even then may be negative.

In all doubtful cases the culture test for gonococci should be employed.

Instrumental Examination.—In all acute inflammatory processes of the urethra instrumental examination is contraindicated. The most convenient instrument for endourethral examination is the elastic bulbous bougie, Guyon's "explorateur à boule olivaire" or bougie à boule. The bougie à boule carries on its slender shaft an olive-shaped head which is conical at its digital end and sharply cut off at its proximal end. The olive, of the most frequently used bougies, has a diameter of 18 to 20, French scale; it is well to have a whole set, these bougies ranging in size from 8 to 26. *In the normal urethra* the bougie passes the anterior part smoothly and without any resistance; at the isthmus the head encounters a slight obstruction; on passing it the patient becomes sensitive to the touch. In the whole length of the membranous urethra the bougie moves slightly engaged; in the prostate it glides easily until we get to the internal orifice, where we feel a slight interference just before it enters the bladder. In some cases the bougie may also be caught in the sinus pocularis.

While passing the prostatic urethra the patient usually has a desire to urinate. The largest diameter of the head of the bougie being at its proximal end, the obstructions of the urethra are felt more distinctly on retracting than when the bougie is introduced. The meatus is often so narrow that we have to cut it for some distance before making an examination. The bulbous urethra is occasionally very wide in the young and often in the old, and catches the end of an inelastic instrument as though it were in a blind pouch. This obstruction may be overcome by stretching the penis. Right behind the bulb is the isthmus, which is usually easy to pass, except in nervous individuals, in whom the membranous urethra is generally hyperemic, and we get reflex spasmodic contraction of the compressor urethræ. Patience and perhaps a few drops of cocaine solution will overcome this obstruction. Any obstructions in the course of the urethra, except those named above, are patho-

logic. In strictures we feel friction and unevenness; it feels as if the bougie jumped over a hard string. If a stricture which is too narrow for the bougie to pass has been found, then filiform bougies are resorted to, starting with the smallest number and gradually increasing to larger ones until the diameter of the stricture is found. Many strictures are sharply limited and stand out prominently from the healthy or less infiltrated surrounding mucous membrane of the urethra, and a filiform bougie introduced is just as likely to be caught in a pocket of the mucous membrane as to enter the narrow passage of the stricture somewhere in the middle. It is, therefore, a good plan not to try to pass the stricture with the first bougie introduced; if it catches in a pocket, introduce the second bougie, and so on until either all of the blind pockets are filled out with the bulb of the bougie or until one accidentally enters the stricture.

We can use conical or cylindrical metal sounds instead of the bougie, but they will not give as much information as the bougie. Infiltrations due to chronic gonorrhea are detected by having the sound in the urethra and palpating with the hand on the surface. The membranous and prostatic urethræ can be palpated through the rectum.

From the foregoing, it is clear that the introduction of a bougie into the urethra not only permits us to find out the degree of sensitiveness and smoothness or unevenness of the urethral mucous membrane, but it also gives direct means to determine the length of the urethra. Most convenient for this purpose are Kutner's graduated bougies.

The diameter of the urethra in its different parts can accurately be measured with the end of the urethrometer. The oldest and most frequently employed is that of Otis. Of newer date is the urethrometer of Kollmann; the latter, in addition, can be used as a dilator for short distance.

Urethroscopy.—The pathologic changes in a large percentage of cases of chronic gonorrhea consist in widespread infiltrations of slight degree, but nevertheless they may cause serious disturbances. In other cases the pathologic changes are confined to small, inflamed, suppurating conglomerations of glands or crypts of Morgagni, which, in spite of their small size, are the carriers of virulent infection and the cause of constant discharge of pus. On the other hand, it is not necessary that they betray their presence by any apparent symptoms. There is no secretion and the urine does not contain any filaments for weeks, months, or even years. Suddenly the patient is attacked by an acute gonorrhea without having exposed himself to infection. Such cases are not rare in every-day practice. The endourethral examination with the bulbous bougie,

the sound, and the urethrometer, while otherwise of great service in making a diagnosis, will give little information in these cases; they remain, therefore, a mystery to the insufficiently equipped physician, and this is what gives chronic gonorrhea the name of being incurable. We must first make a correct diagnosis before we can successfully treat a disease. The most important instrument with which to make a thorough examination is the urethroscope.

PHIMOSIS.

This is an abnormal narrowing of the foreskin, so that it cannot be retracted to expose the glans. It is most often a congenital condition, but may be acquired as the result of gonorrheal inflammation or chancroidal ulceration beneath the prepuce.

The chief interest from a diagnostic point of view is in the results of the phimosis. These are: (*a*) Recurrent attacks of balanitis from accumulation of smegma. (*b*) Prolapse of the rectum or a hernial protrusion as the result of straining. (*c*) Formation of preputial calculi. (*d*) It favors the development of an epithelioma through irritation of the secretions. It is a frequent cause of reflex nervous symptoms in children.

PARAPHIMOSIS.

Whenever a tight foreskin has been drawn back over the glans penis and is not allowed to slip forward again, a *paraphimosis* results. This is due to the formation of a contraction ring in the retracted foreskin which prevents the blood from returning toward the root of the penis, causing marked swelling. The condition can be readily recognized from this swelling, which lies just behind the corona glandis and is separated from the main body of the penis by a deep groove corresponding to the contraction ring. The longer the paraphimosis lasts, the more swelling, so that the groove or contraction ring may be entirely hidden. It may be followed by gangrene of the foreskin.

BALANITIS.

This is the result of an infection of the inner or mucous layer of the prepuce. The entire prepuce is swollen and tender so that it can only be retracted with difficulty. The glans penis and inner layer of the prepuce are both reddened and ulcerated, and a foul purulent discharge is present. The retention of secretion may lead to deep ulceration and gangrene of the prepuce. This condition is at times the first sign of the presence of a diabetes.

EPITHELIOMA OF THE PENIS.

This occurs late in life. It occurs usually in one of two forms, either as a cauliflower-like growth (Fig. 273) or as an ulceration with undermined and markedly indurated edges. The former is the more frequent. If it is present with a tight prepuce the diagnosis may be made from the purulent discharge, by palpating the induration through the intact prepuce, and by the indurated, enlarged inguinal lymph-nodes. A little later, when the tumor has penetrated the prepuce, the diagnosis is much easier. The discharge may be the first symptom which calls the patient's attention to his condition.

FIG. 273.—TYPICAL PAPILLARY CARCINOMA OF PREPUCE PERFORATING OUTER LAYER OF SAME.

The second or ulcerative form resembles somewhat the carcinomata of the lip with their crater-like ulceration, indurated bases, and edges.

In the differential diagnosis of the cauliflower form one must consider venereal warts. These are softer and there is no induration of the base or of the inguinal lymph-nodes. *From the ulcerative form* one must differentiate a chancre and a gumma. In neither of these are the edges or base as hard as in carcinoma. In chancre there may be enlargement of the inguinal nodes, but they are never as indurated, and the primary lesion is followed by other secondary symptoms within a few weeks. If any doubt exists, the administration of antisyphilitic remedies will soon clear up a chancre.

In the case of a gumma of the penis the same clinical findings hold true. The edges or base are never as indurated, there are no enlarged inguinal nodes, and there is usually the history of syphilis or evidence of its presence elsewhere. The administration of potassium iodid should cause a marked difference in the appearance of the ulceration within a week.

THE TESTES.

ABNORMALITIES IN DEVELOPMENT.

A lack of development of the testis may occur in an imperfectly or in a perfectly descended testis. It is more frequently associated with the former, but it must not be assumed that every testis which has not reached the scrotum is incapable of producing healthy spermatozoa. The latter property is, however, lacking in the majority of such cases.

FIG. 274.—INFANTILISM IN A PATIENT, THIRTY YEARS OF AGE, DUE TO NON-DEVELOPMENT OF TESTES, WITH NORMAL DESCENT OF THESE ORGANS.

Such non-developed testes may not show any perceptible decrease in size, but usually they are much smaller than the normal organ. One can recognize such non-development clinically by the absence of many of the male characteristics, the lack of pubic hair, the infantile size of the penis and scrotum (Fig. 274), the smooth, soft, child-like, hairless skin and fat of the entire body. In some cases this so-called infantilism is accompanied by a high-pitched, almost feminine voice, and in the case shown in Fig. 274 there was a lack of mental development. The term "atrophy of the testis" should be confined to those cases in which the organ has been normally developed, but has undergone retrograde changes, as may occur after acute inflammations, such as the orchitis following mumps or injuries. Occasionally such atrophy may take place after operations for inguinal hernia, or in a moderate degree as a result of a marked varicocele of long standing.

IMPERFECT DESCENT OF THE TESTIS AND ITS COMPLICATIONS.

If the testis is arrested in its migration from the abdominal cavity to the scrotum, the condition is called non-descent or retention of the testis. If it has pressed through the inguinal canal and then assumes an abnormal position, it is called an ectopia or abnormal descent.

In the case of the *retained testis* the organ may be arrested (*a*) within the abdomen, (*b*) in the inguinal canal (Fig. 275), and (*c*) just below the external abdominal ring (Fig. 275). In *ectopia testis* the organ has been found beneath the skin of the anterior abdominal wall, in the femoral region (Fig. 276), in the perineum (Fig. 277), at the root of the penis or toward the anterior superior spine of the ilium.

FIG. 275.—MOST FREQUENT LOCATIONS OF TESTIS IN CASES OF NON-DESCENT.

1, Location of testis within inguinal canal; 2, location just outside of external abdominal ring. The third most frequent position (abdominal testis) is not shown in the picture.

In examining a child for for a retained testis, it must be remembered that children possess the ability to draw the testis, even when normally descended, into the inguinal canal almost as far as the internal ring (Fig. 278).

The presence of a retained or abnormally descended testis may be readily recognized by first palpating the scrotum, when one or both sides will be found empty. Careful search should then be made, in the places where the testes are usually retained or abnormally placed, for a soft, oval, easily movable tumor corresponding to the testis. In children the organs may be retained in the inguinal canal until near puberty and then suddenly descend. An abnormally retained testis cannot be palpated, and the first sign of its presence may be an inflammation.

The following conditions may develop in or accompany a retained or abnormally descended testis:

1. Inflammation.
2. Torsion of the cord (Fig. 270).
3. Tumor formation.
4. Hydrocele and hernia.

1. **Inflammation.**—This is especially apt to occur in an imperfectly descended testis, often from torsion of the cord. The situation of the local inflammatory signs (pain, swelling, etc.) varies according to the location of the organ. The pain is more intense than in inflammation of the normally placed organ, and is apt to be accompanied by nausea and vomiting greatly resembling a strangulated hernia or an inflamed lymph-node if located in the femoral or inguinal regions. If situated within the abdomen the condition may resemble an appendicitis or some other acute abdominal condition.

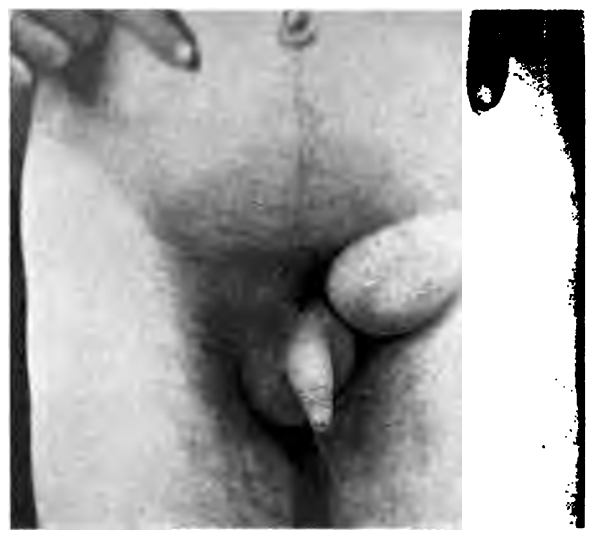


FIG. 270.—LOCATION OF TESTIS IN FEMORAL REGION (Eccles).
The testis is arrested over Scarpa's triangle; the left side of the scrotum is atrophied.

In inflammation there is an absence of the testis in the scrotum on the affected side, the onset is not as sudden, nor do the nausea, vomiting, or constipation, if present, persist as they do in strangulation. The local tenderness and swelling are also more marked in an inflamed testis and there is more apt to be fever and leukocytosis early.

From an *inflamed lymph-node* the diagnosis is not as difficult. There is usually some primary focus for the enlarged node to be found, the testis is present on the inflamed side, and the swelling is more superficial than in an inflamed testis.

2. This has been discussed **above.**

3. **Tumor Formation.**—It has been [redacted] believed that tumors

were more likely to develop in an imperfectly descended testis, but Eccles, who has examined 854 cases of this condition, believes that malignant disease is not more frequent than in the normally descended organ.

FIG. 277.—LEFT TESTIS IN PERINEUM OF AN INFANT (Eccles).

It is well to remember that a gradual enlargement of an inguinal tumor, if the testis on the same side has not descended into the scrotum, must be regarded with suspicion. The first sign of its malignant character may be the evidence of a distant bone metastasis.

Hernia and Hydrocele in Connection with Imperfect Descent.—Hernia occurs in about one-half of the cases of undescended testis and is most often

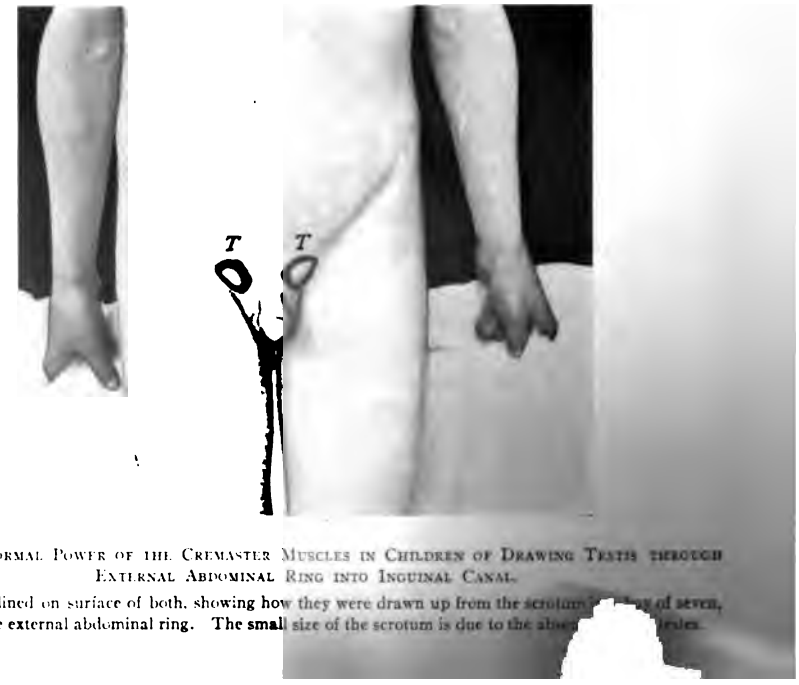


FIG. 278.—NORMAL POWER OF THE CREMASTER MUSCLES IN CHILDREN OF DRAWING TESTIS THROUGH EXTERNAL ABDOMINAL RING INTO INGUINAL CANAL.

T, Testes outlined on surface of both, showing how they were drawn up from the scrotum [illegible] of seven, as far as the external abdominal ring. The small size of the scrotum is due to the absence [illegible] testes.

of the congenital inguinal variety. Hydrocele is also a frequent accompaniment.

INFECTIONS OF THE MALE REPRODUCTIVE ORGANS.

For diagnostic purposes it will be found of service to include the diseases of the vas deferens, seminal vesicles, and prostate with those of the testis and epididymis, since in many of the cases of pathologic conditions of these latter there are coexisting changes in the three first-named structures. This is especially true of gonorrhea (page 444) and tuberculosis.

FIG. 270.—STRANGULATION OF A TESTIS DUE TO TORSION OF ITS CORD (Eccles).

The darker patches indicate extravasation of blood into its substance. This condition was present in a case of non-descent of the testis, the latter being arrested in the inguinal canal.

One of the most important lessons to learn before attempting to make a diagnosis of these conditions is to practise palpation of the same structures either on the non-affected side or in normal individuals. A physician must accustom himself to the consistency and relations to each other, of the body of the testis or orchis proper, and of the epididymis. In the latter, one must learn to distinguish the head or upper pole from the tail or lower pole.

The vas deferens should also be palpated and followed toward the external abdominal ring. By rectal examination the normal prostate should be palpated. The seminal vesicles cannot be felt unless enlarged.

The best position for an examination of the testis and epididymis is to palpate the organs of the right side with the left, and vice versâ (Fig. 280).

The chief pathologic conditions of these structures which are of clinical interest can be conveniently divided for diagnostic purposes into two classes, as follows:

Acute (Fig. 282).	Chronic (Fig. 283).
1. *Gonorrhea* most often involves the epididymis and vas deferens, rarely the body.	1. *Tuberculosis* in early stages involves first the head of the epididymis, later the entire epididymis and vas. Rarely does it begin acutely or associated with gonorrheal epididymitis.
2. *Trauma* usually causes enlargement of body of testis or orchis proper, rarely of the epididymis.	2. *Syphilis* in majority of cases involves body or orchis proper. Epididymis rarely involved alone or in conjunction with orchitis. Gumma of vas deferens quite rare.
3. *Enlargement following epidemic parotitis* (*mumps*) always involves body of testis or orchis proper.	3. *Neoplasms*, whether benign or malignant, always begin in the orchis proper or body of testis.
4. *Cystitis of non-gonorrheal origin may be followed by an epididymitis* (especially with enlarged prostate).	
5. *Typhoid and influenza* rarely are followed by an epididymitis.	

The above table holds true for the majority of cases. Cases will be met with, however, in which a tuberculosis may begin very acutely or develop upon an acute gonorrheal epididymitis, or the exceptional cases referred to under syphilis may occur. In general, however, such a table will be found a convenient guide.

The principal diagnostic features of these various affections follow:

Gonorrheal Epididymitis and Orchitis.—This occurs in the second or third week of an acute attack or in the course of a chronic case after the passage of sounds or massage of the prostate.

The epididymis is greatly and uniformly enlarged and tender. The structure rests like a cap upon the orchis, and the latter can be distinctly felt unless an acute gonorrheal hydrocele (periorchitis serosa acuta) coexists; then a double enlargement with a depression between is to be felt (Fig. 282). The existence of an acute urethritis, in the pus of which the gonococcus can be demonstrated, confirms the diagnosis. The temperature varies from 101° to 104° F. The vas deferens is greatly enlarged and very tender. The disease may occasionally begin with severe pain along the intra-abdominal portion of the vas deferens. When an epididymitis sets in, the urethral discharge usually ceases temporarily. The epididymis remains enlarged and tender at times for months after an attack. Abscesses may form, especially after a gonorrheal orchitis.

Less often is the orchis or body of the testis involved in a gonorrheal inflammation. One can then feel a smooth, oval, tender, scr[illegible]mor, upon which the epididymis rests, unless an acute hydrocele [illegible]it.

TRAUMATIC AFFECTIONS.

These usually affect the body of the testis, especially after a kick or blow on the scrotum. The epididymis or vas deferens may occasionally be inflamed after heavy lifting. If they result from lifting some heavy object, the epididymis may be most involved. The diagnosis can be readily made from the history, the palpatory findings, and the exclusion of gonorrheal infection.

FIG. 280.—METHOD OF EXAMINING THE VAS DEFERENS ON EITHER SIDE.

The examination of the right vas deferens or veins of the spermatic can be best carried out by standing either in front or upon the right side of the patient, and grasping the structures between the index-finger and thumb of the left hand. The same method may be followed in the examination of the vas deferens for spermatic veins on the left side by grasping it between the right thumb and index-finger.

TUBERCULOSIS.

This disease usually begins in a slow, insidious manner. A number of cases have, however, been reported of a very acute development, especially in children and young adults. The author has reported a typical case in which it followed an acute gonorrheal epididymitis without perceptible interval.

The testis is usually involved at a later period, so that it is possible at such a time to find that the testis and the epididymis are involved to such an extent as to feel like a continuous body through the scrotum.

[illegible] disease may follow trauma as well as gonorrheal inflammation [illegible]losis elsewhere. A search for all of these should be

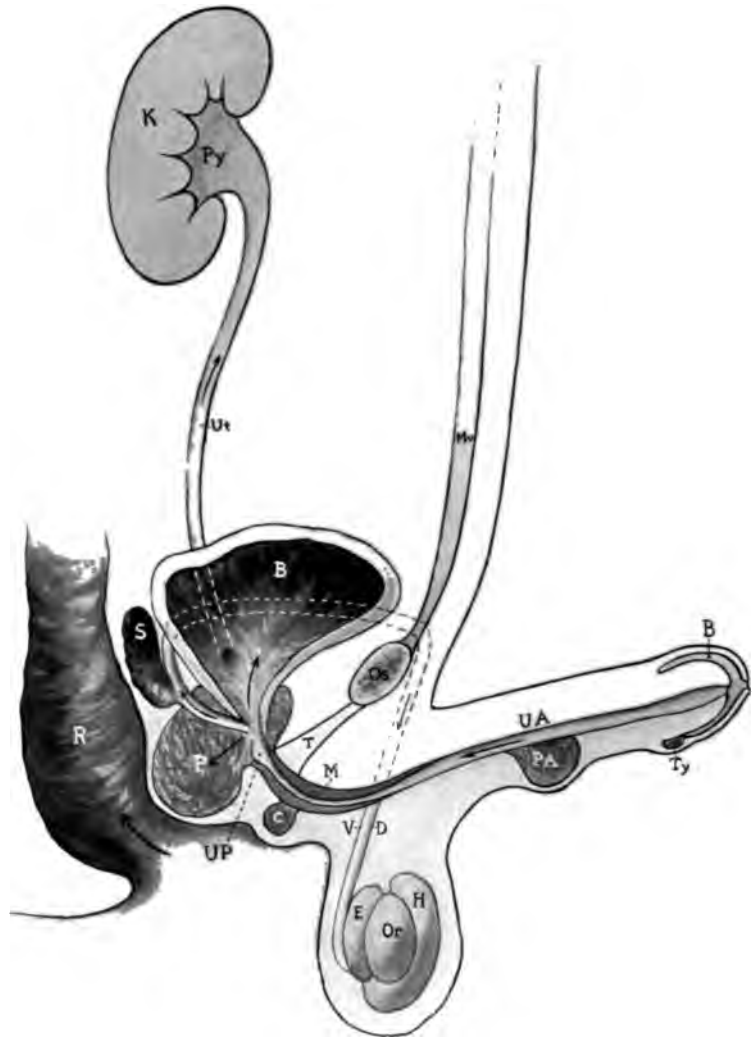


FIG. 251.—LOCALIZATION OF GONORRHEAL INFECTION IN THE MALE GENITO-URINARY ORGANS (SEMIDIAGRAMMATIC).

K, Parenchyma of kidney; Py, gonorrheal pyelitis; Ut, gonorrheal ureteritis; **the arrow points the direction** in which the infection ascends from the bladder to the kidney; B, bladder wall; **the arrow at the neck of the** bladder indicates the direction of the infection from the urethra to the bladder (**gonorrheal cystitis**); **UP, seat** of posterior urethritis; M, infiltration of urethral walls at bulbo-membranous **junction—most frequent seat** of gonorrheal stricture; UA, anterior urethra; T, triangular ligament which divides **the urethra into the anterior** and posterior portions. Os, symphysis pubis, from which triangular ligament is **suspended; PA, periurethral** abscess; B, balano posthitis; Ty, inflammation of Tyson's gland. P, seat of prostatic **abscess, pointing toward** the perineum, involving bulging of the anterior wall of the rectum. R, rectum; **the arrow shows the direction in** which infection occurs causing a gonorrheal proctitis; V-D, seat of the vas deferentitis; **E, seat of gonorrheal** epididymitis; Or, orchis, or body of testis; H, seat of acute gonorrheal hydrocele; **Mu, musculature of abdom**inal wall; S, seminal vesicles, the seat of gonorrheal vesiculitis, the arrow shows how **transmission is effected** from the posterior urethra to the seminal vesicles and vas deferens, from the latter to **the epididymis, etc.**

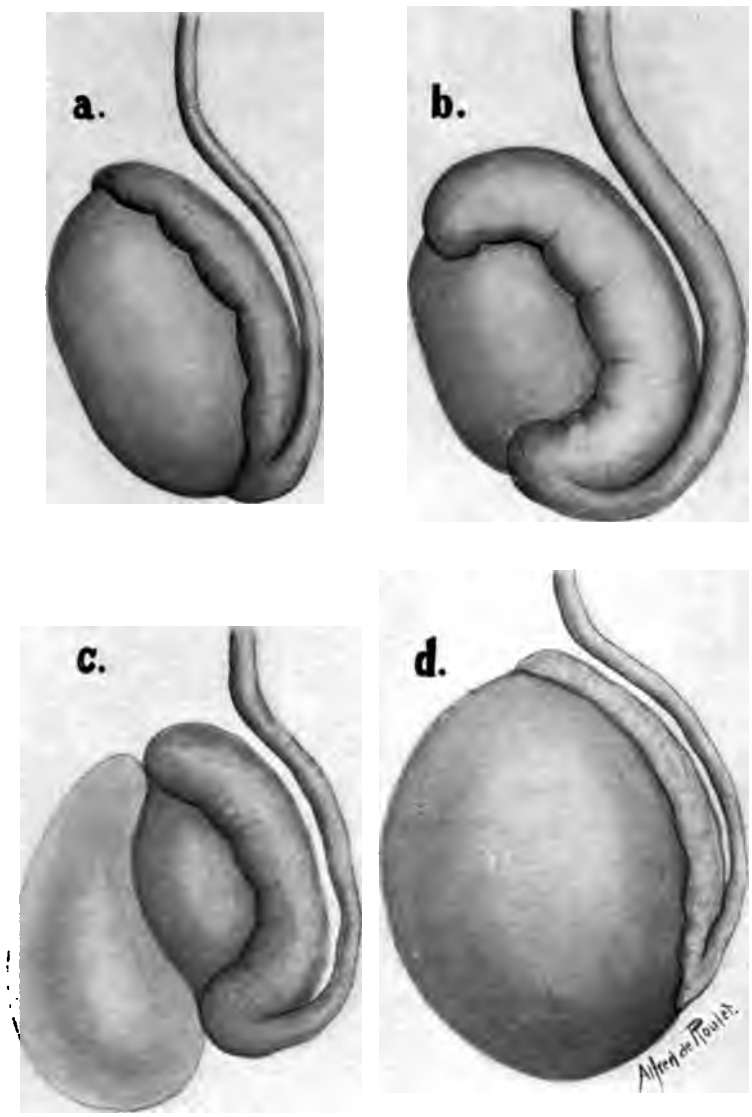


FIG. 282.—DIFFERENTIAL DIAGNOSIS OF ACUTE ENLARGEMENTS OF THE TESTIS AND EPIDIDYMIS.

a, Normal testis. *b*, Gonorrheal epididymitis and vas deferentitis. Note the marked enlargement of the epididymis and spermatic cord as compared to the normal structures, and how the epididymis almost encloses the testis. *c*, Acute gonorrheal epididymitis, deferentitis and acute gonorrheal hydrocele. *d*, Acute orchitis following trauma of the testis, and the characteristic enlargement of the body of the testis (orchis) following mumps, and other infectious diseases.

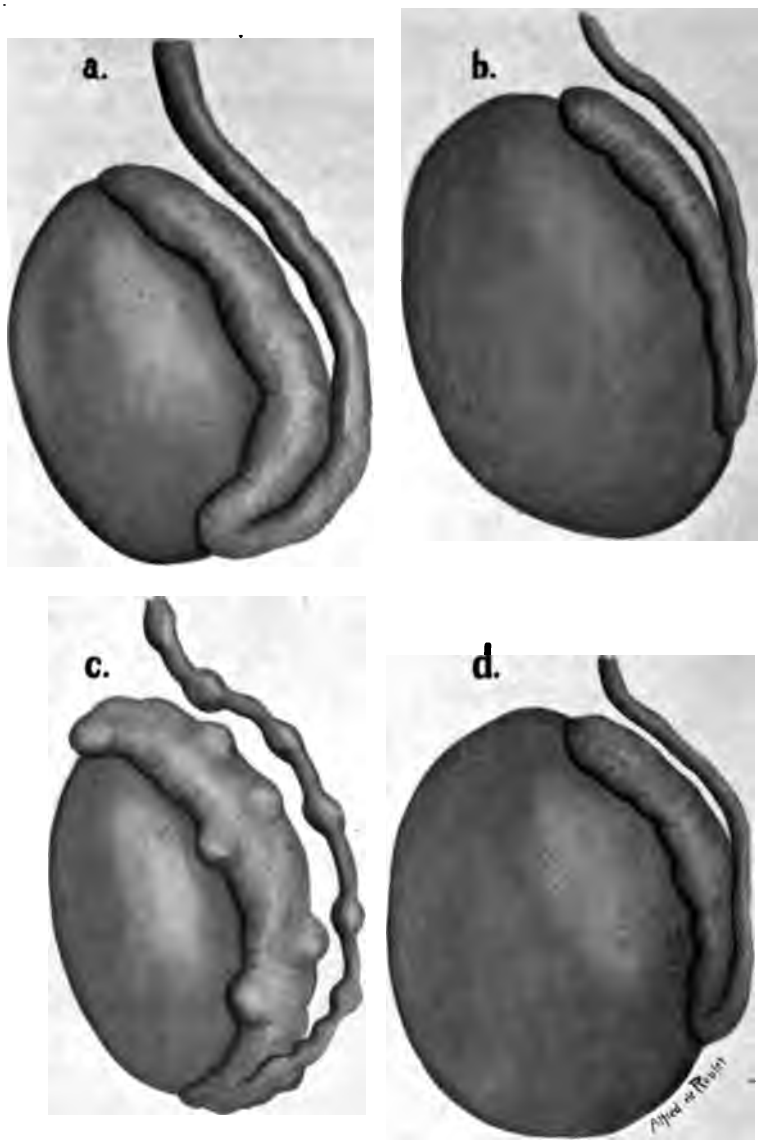


FIG. 288.—DIFFERENTIAL DIAGNOSIS OF THE CHRONIC ENLARGEMENTS OF THE TESTIS AND EPIDIDYMIS.

a, Syphilis of testis. This is one of the two forms in which syphilis affects the testis. In this variety both testis, that is, the body of the testis (orchis), and epididymis are enlarged. (See text.) *b*, Second variety of syphilitic affection of the testis. In this form the orchis or body of the testis is predominantly enlarged, giving rise to a large tumor, syphilitic orchitis, or sarcocele. *c*, Tuberculosis of the testis. This illustration shows the most frequent localization of tuberculosis, especially in its early stages, involving especially the tail of the testis and the vas deferens, in the form of a nodulated enlargement of the former, and a beaded one of the latter. *d*, Tumors of the testis. This illustration shows how tumors, both benign and malignant, of the testis almost exclusively affect the body of the testis.

In the majority of cases the disease begins slowly. One or more hard nodules can be felt in the upper part of the epididymis, so that it feels very irregular. Later a similar condition of the entire epididymis can be felt and the vas deferens is thickened and bead-like on palpation. Early abscess formation and formation of a sinus in the scrotal skin, with discharge of thick, cheesy pus, speak for tuberculosis. An examination of the prostate and seminal vesicles will show hard nodules in many cases. If the disease is advanced, tubercle bacilli may be demonstrated in the urine, as referred to, in the diagnosis of renal tuberculosis.

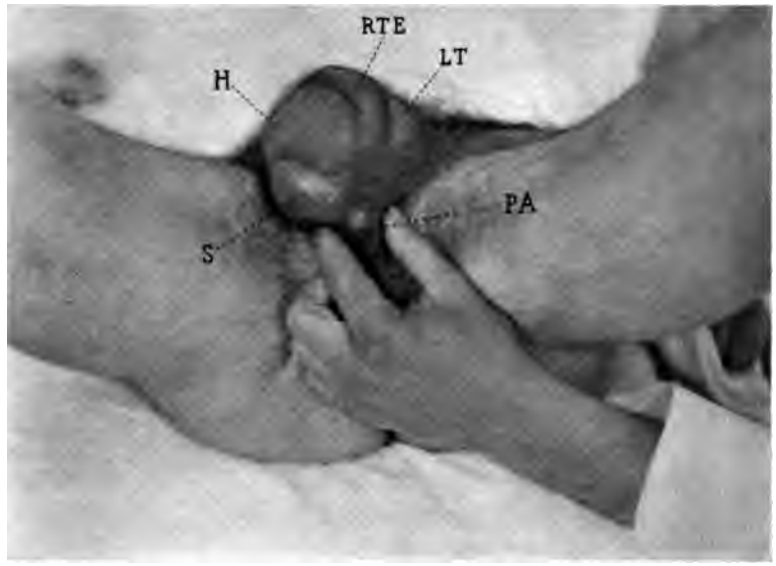


FIG. 284.—COMPLICATIONS FOLLOWING GONORRHEAL URETHRITIS.

PA, Periurethral abscess grasped between the thumb and index-finger; S, collection of serum between periurethral abscess and acute gonorrheal hydrocele (H); RTE, inflamed epididymis of right testis: LT, left testis.

It is rarely necessary to resort to a tuberculin test and reliance can seldom be placed upon a negative result after the use of tuberculin.

Tuberculosis must be differentiated from a chronic enlargement which may be a sequel of an acute epididymitis. The induration of such a chronic epididymitis is usually diffuse and tender, the vas is smooth and firm, and the history of a previous acute gonorrheal attack and examination of the urine will clear up any doubts. In those cases referred to above, in which the tuberculous condition develops directly upon a gonorrheal, the diagnosis can only be made from the more nodulated outline in tuberculosis, and similar nodules in the vas and prostate, or

by the discovery of the tubercle bacilli in the urine or in the pus of a sinus, if one exists.

Syphilis usually affects the body of the testis and but rarely the epididymis. The induration is not nodulated if it affects the epididymis, and the history and the administration of potassium iodid will render a differentiation possible.

SYPHILIS.

A gradual, almost painless enlargement of the body of one or both testes occurs. An acute onset with pain, is very rare. The enlarged

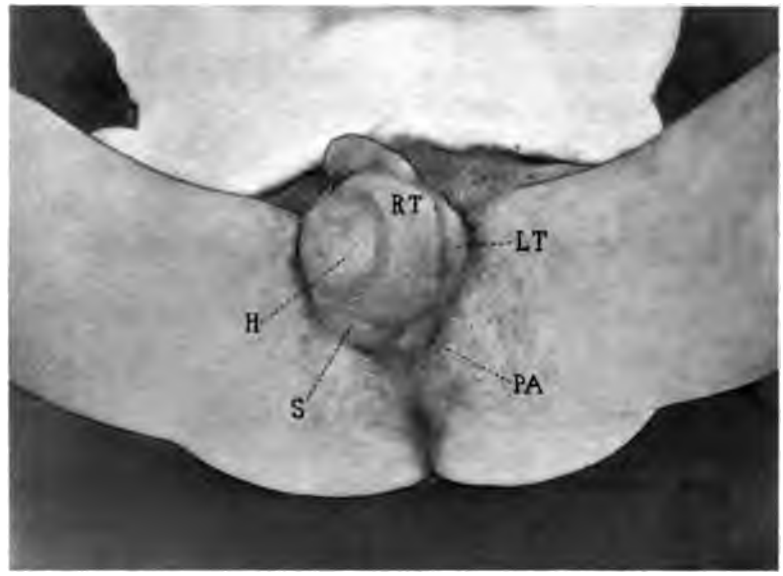


FIG. 285.—VIEW FROM THE FRONT OF CONDITIONS ILLUSTRATED IN FIG. 284.

The limbs of the patient were widely separated in order to take the photograph. PA, Periurethral abscess; S, collection of serum at lowest portion of scrotum; H, acute gonorrheal hydrocele; RT, inflamed right epididymis; LT, inflamed left testis.

orchis can be readily felt as an oval, smooth, painless tumor in the scrotum. The epididymis and vas are rarely involved. In one case, in which such a complication occurred, I was able to differentiate it from tuberculosis by the absence of nodulation and the more diffuse character of the induration, as well as the history and the absence of sinuses. The existence of a large accompanying hydrocele may at times obscure the existence of a syphilitic orchitis until the fluid is evacuated.

TUMORS OF THE TESTIS AND EPIDIDYMIS.

These may be divided into:

Benign.—(*a*) Spermatocele. (*b*) Adenoma and cystadenoma testis. (*c*) Dermoids and teratoma.

Malignant.—(*a*) Sarcoma. (*b*) Mixed tumors.

SPERMATOCELE.

This form of tumor, which is really a retention cyst of the epididymis, can be felt as a tumor which grows slowly to the size of an adult fist. The tumor either shows distinct fluctuation or is quite tense. It can be felt as either separating the testis proper from the epididymis or it feels like a hydrocele. It can be recognized on exploratory puncture as a spermatocele by its milky contents, which contain spermatozoa.

NEOPLASMS OF THE TESTIS.

In the diagnosis of neoplasms of the testis two questions present themselves: (1) Is the enlargement of the organ a neoplasm? (2) What is the nature of the new-growth?

In answering the first question, it is necessary to first determine by palpation whether the body of the testis or the epididymis is involved or whether the enlargement is one of the tunica vaginalis, *e. g.*, hydrocele, hematocele, etc.

If the enlargement is found to be of the epididymis alone, the question of a neoplasm need not enter into consideration, since the principal enlargements of this structure are due to gonorrhea, syphilis, and tuberculosis (see page 454). If the enlargement is of the body of the testis the chief condition to be differentiated from a neoplasm is syphilis. In cases where there is a clear history of this latter condition the diagnosis will present no difficulties. The syphilitic enlargements are more stationary, showing but little tendency to an increase in size. The only variety of neoplasm which causes such a gradual enlargement of the testis is the ***benign adenocystoma***, but even in this form the increase in size is more progressive than in syphilis. The patients will usually give the history of a more rapid enlargement than in the case of syphilis. The administration of potassium iodid for a week will usually clear up the diagnosis in those cases in which the history is not clear and there are no other evidences of syphilis to be found in the body. **A malignant neoplasm of the testis can be readily distinguished from syphilis by its rapid growth.**

A hydrocele can be differentiated by the absence of enlargement of the body of the testis, by the translucency test (Fig. 286), and by the use of the aspirator or trocar for the withdrawal of some of the hydrocele fluid.

At times it is almost impossible to differentiate a hematocele from a neoplasm of the testis. In the latter the tumor is heavier and there is an absence of inflammation and of syphilis, the latter being the most frequent cause of a hematocele, also called periorchitis hemorrhagica.

The second question to be answered is, What is the nature of the neoplasm? Tumors of the testis may be divided into two great groups—benign and malignant. The benign are the adenocystomata, which are the most frequent, and the rarer forms, such as dermoid cysts. Of the latter only a few cases have been reported. The malignant varieties belong either to the sarcomata proper or to the so-called mixed tumors recently studied by Wilms. The majority of the cases of sarcomata of the testis belong to the small round-celled or spindle-celled varieties. They grow very rapidly, often appear simultaneously in both testes, and spread along the spermatic cord and inguinal lymph-nodes to the retroperitoneal nodes. Metastases appear very early. The mixed tumors contain muscle fibers, cartilage, myxomatous tissue, glandular acini, bone, and blood-vessels in varying proportions and combinations. Many text-books speak of cases of carcinoma, but their existence is denied by other equally good authorities.

Clinically, the only distinction between the benign and malignant neoplasms is their rate of growth. The malignant varieties, especially the sarcomata, cause so rapid an enlargement of the body of the testis that a diagnosis can be readily made. Accompanying this increase in size there is involvement of the spermatic cord and inguinal retroperitoneal lymph-nodes, all of which can be determined by palpation. Sarcomata are most common in children before the age of ten, and again in adults between thirty and forty. In the benign varieties of neoplasms of the testis the oval shape of the testicle is preserved. As the gradual increase in size occurs the surface becomes nodulated and softer in places.

The *mixed tumors* form a clinical group by themselves. They cause, at times, a gradual enlargement of the testis; at others, a very rapid one. After their removal they are most apt to cause metastases in the lungs and bones (Fig. 488).

HERNIA.

A hernia may be defined as the *abnormal protrusion of a viscus from any preformed cavity of the body*. The term is, however, limited to those protrusions in which a portion of the abdominal viscera escapes through openings in the muscular or bony wall.

The opening through which a hernia escapes is called the hernial ring or rings (if there are two, as in the case of an indirect inguinal hernia).

The most frequent varieties of herniæ are the inguinal (73.4 per cent.),

FIG. 280.—METHOD OF DETERMINING THE TRANSLUCENCY OF A SCROTAL TUMOR IN ORDER TO MAKE A DIAGNOSIS OF HYDROCELE FROM THAT OF A SOLID TUMOR OF THE TESTIS OR FROM A HERNIA.

An electric lamp or candle is held on the distal side of the tumor, while the examiner places a roll of paper or a cylinder against the scrotal tumor on the side opposite to that on which the light has been placed. In case of a hydrocele, the light is readily transmitted through it.

the femoral (18 per cent.), and the umbilical (8.47 per cent.). The fraction remaining—*i. e.*, 0.12 per cent. (Eccles)—represents the ventral, obturator, sciatic, lumbar, perineal, vaginal, and diaphragmatic varieties in the order named. The contents of a hernial sac are most often intestines and omentum. Gurgling and tympany speak for the former, while a nodulated surface and dullness on percussion speak for the latter (omentum).

Among rarer contents may be mentioned: (*a*) Ovary (increases in size and becomes more tender during [redacted]) testicle, feel-

	Reducible Hernia.	Simple Irreducible Hernia.	Strangulated Partial Enterocele.	Strangulated Complete Hernia.	Inflamed Hernia.	Obstructed or Incarcerated Hernia.
Swelling.....	In hernial region.	In hernial region.	Usually none to be felt.	Larger than before and firmer.	Larger than before.	Larger than before.
Impulse.....	Distinct on coughing.	Distinct on coughing.	None.	None.	Present on coughing.	Present on coughing, but less marked.
Reducibility..	Disappears on lying down or manipulation.	Does not disappear after same tests.	Irreducible.	Irreducible.	Generally reducible, but may not be.	Irreducible.
Other local signs.....	Soft if intestine, firmer if omentum.	Usually feels firm and doughy.	Some pain over hernial region.	Dull pain over swelling, later signs of peritonitis.	Redness, pain, local heat.	....
Signs of obstruction...	None.	None.	Not as marked as in complete form. May pass liquid feces and gas; vomiting not so marked.	Colicky pains, absolute constipation; vomiting; later fecal.	But little nausea. No absolute constipation.	Gradual onset; vomiting slight; bowels can be moved. Occurs in aged.
General disturbances..	None.	None.	Not as early as in complete.	Marked and early intoxication.	Fever and leukocytosis.	Slight, no collapse.

ing smooth, firm, and like a plum; (*c*) vermiform appendix; (*d*) urinary bladder; (*e*) uterus or tubes; (*f*) Meckel's diverticulum (Fig. 183); (*g*) rarely the stomach, liver, or spleen; (*h*) ureter (quite rare); (*i*) those in which the cecum is so placed that its mesocolon forms the wall of the sac. Such a hernia is called "sliding hernia of the cecum."

A hernia is said to be reducible when its contents can be returned into the abdominal cavity upon gentle manipulation or when the patient lies down. It is said to be irreducible when the above tests result negatively.

The following complications of both reducible and irreducible herniæ may occur. They are more frequent in the irreducible variety.

1. The lumen of the bowel becomes obstructed from within through stagnation of feces. This is called an *incarcerated or obstructed hernia.*

2. The sac wall or even the contents (especially omentum) become acutely inflamed

from causes both within and external to the sac. This is called an *inflamed hernia*, and if it occurs in the reducible variety, adhesions form and produce irreducibility.

3. *Strangulated hernia.* In this complication there is interference with the passage of feces through the intestinal lumen and secondary gangrene of the bowel wall as the result of interference with the circulation.

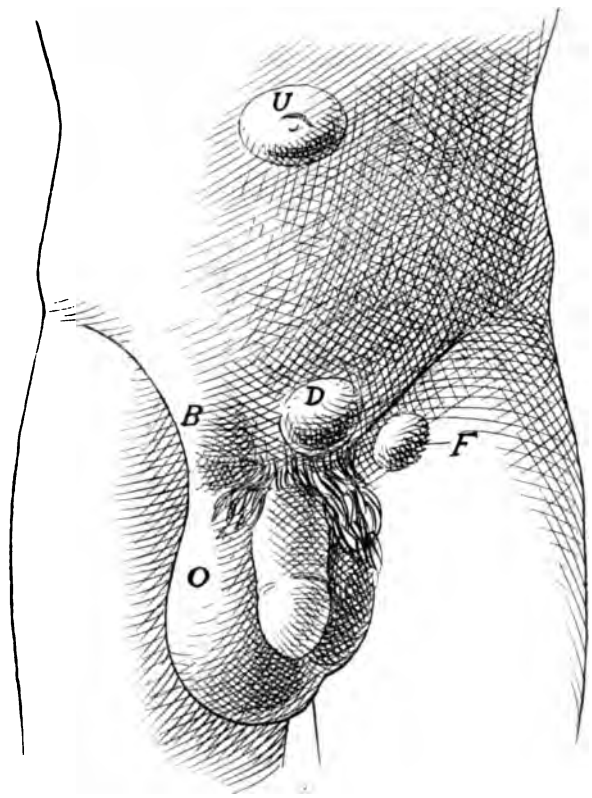


FIG. 287.—LOCATION OF VARIOUS FORMS OF ABDOMINAL HERNIÆ (DIAGRAMMATIC).
U, Umbilical hernia; *D*, direct inguinal hernia; *B*, indirect incomplete inguinal hernia: *O*, complete or scrotal inguinal hernia; *F*, femoral hernia.

Strangulation most often follows a sudden increase in abdominal pressure, as in coughing, lifting, straining at stool, etc.

The principal diagnostic points of reducible and irreducible herniæ and their complications are given in the table on page 464.

It is very difficult to differentiate between an obstructed and a strangulated, and again, between an inflamed and a strangulated hernia, since acute strangulation may occur in an obstructed hernia and the

inflammation may spread to the general peritoneal cavity from an inflamed hernia. At the present time, operation is indicated in every case of irreducible hernia accompanied by local signs, such as pain, tenderness and constipation or nausea and vomiting. Hence the above differential points have often only a theoretic value. ***Emphasis cannot be too strongly laid upon the danger of forced taxis in the efforts to reduce an irreducible hernia for the purposes of diagnosis or treatment, whether or not such a hernia be accompanied by signs of inflammation or obstruction.***

In the table on page 464, attention is called to the fact that strangulation of only a portion of the wall of the gut (***acute partial enterocele***[1]) may occur, causing far less marked symptoms of intestinal obstruction than if if the whole circumference be strangulated. The same atypical clinical picture may appear if the appendix or, as rarely occurs, a Meckel's diverticulum is strangulated. As in acute partial enterocele, the bowels may move normally or there may even be diarrhea. Here localized tenderness over the hernial region is the most valuable sign. Other atypical forms are: (*a*) When strangulation occurs within the sac or (*b*) where it takes place in a multiloculated sac. In both of these the impulse on coughing may be retained.

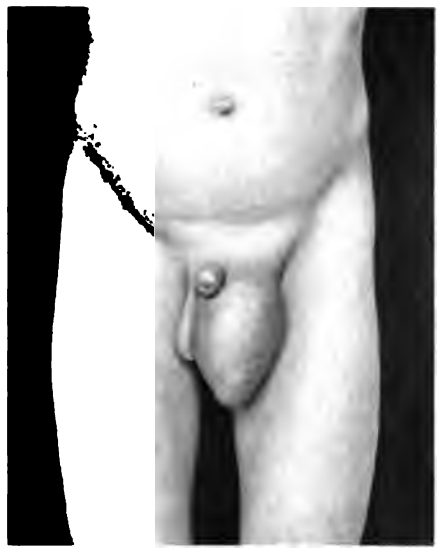


FIG. 288.—LEFT-SIDED CONGENITAL COMPLETE INGUINAL HERNIA IN A BOY OF EIGHT.

Note the location of the testis at the lowest portion of the scrotum.

Again, two or more irreducible herniæ may coexist, as in the case shown in Fig 290 (femoral and inguinal). It is then difficult to say which has been strangulated. But in all of these anomalous forms the local tenderness is the most important symptom.

INGUINAL HERNIA.

This may be of three varieties:

1. Indirect or oblique.

[1] This form of partial strangulation of a gut has also been called a Littré hernia.

2. Direct.

3. Interstitial.

1. **Indirect or Oblique Inguinal Hernia.**—As long as the sac and its contents remain within the inguinal canal this form is called an incomplete indirect or oblique inguinal hernia or bubonocele. When the sac and its contents protrude through the external abdominal ring (Fig. 288) into the scrotum, it is called a complete or scrotal hernia.

FIG. 289.—METHOD OF INVAGINATING THE SCROTUM IN ORDER TO DETERMINE THE SIZE OF THE EXTERNAL ABDOMINAL RING.

When examining the left external abdominal ring, as in the illustration, the left index and middle fingers of the examiner should be used. This can best be done when the patient stands upon a chair. The scrotum is then invaginated, until the index-finger feels the spine of the pubis, to the inner side of which the oval opening of the external abdominal ring, which in adults normally admits the index-finger, can be distinctly felt. The impulse of a hernia can be best felt in this manner. The patient is instructed to cough while the index-finger is placed in the external abdominal ring.

The incomplete form may be recognized as a swelling which causes a prominence along the course of the inguinal canal (from the internal to the external abdominal ring).

The swelling has all of the characteristics of a reducible hernia, viz., that it causes a swelling in a hernial region having all the properties referred to on page 464.

There is a distinct impulse to be felt on coughing (Fig. 289). The swelling becomes more visibly prominent when the patient coughs or

strains or stands up. It can be caused to disappear by light taxis or when the patient lies down. The impulse is often best felt by invaginating the scrotum and inserting the index-finger (Fig. 289) through the external ring into the canal.

When the hernia is of the complete or scrotal variety the position of the swelling at the upper end of one side of the scrotum, passing up into the groin on the outer side of the pubic spine, is typical. It can usually be readily reduced upon lying down and caused to reappear when the patient coughs. The size of the external ring varies according to age, and to some extent in different individuals. In general, it admits the index-finger in adults and the little finger in children. In inguinal herniæ, especially if they are of long standing, the ring will often admit three to four finger-tips. The internal ring cannot be felt. If the hernia has existed for many years, the external and internal rings may come to lie opposite each other, so that after the contents are reduced, the finger inserted through the external ring seems to sink directly toward the peritoneal cavity, there being no posterior wall to the canal. This variety is called a *straight hernia*. An inguinal hernia may be so large that no trace of the penis is to be found (Fig. 290).

FIG. 290.—ENORMOUS DOUBLE INGUINAL HERNIÆ.

The right was reducible, but the left was irreducible. The depression in the center of the scrotal mass shows the atrophy of the penis, the organ being entirely hidden in cases of large herniæ. The illustration also shows an enormous layer of abdominal fat, which the patient was able to pick up in his hands, in order to have the hernia photographed.

2. **Direct Inguinal Hernia.**—A direct inguinal hernia appears at the outer edge of the rectus and is usually much smaller than the oblique form and more rounded (Fig. 296). It is very difficult to distinguish it

from the above mentioned straight hernia, having the same palpatory findings and occurring, like it, in elderly people. It is almost impossible to state positively that the hernia is a direct one in such cases until at operation, the deep epigastric artery is found along the outer border of the sac.

3. **Interstitial Hernia.**—There are three varieties of this hernia (Fig. 293) and they are usually accompanied by non-descent of the testis. The first or subaponeurotic variety is that in which the sac lies between the internal and external oblique muscles. This variety is more common

FIG. 291.—TYPICAL APPEARANCE OF A CASE OF LEFT-SIDED COMPLETE OBLIQUE INGUINAL HERNIA. Note the depression between the lower border of the hernia and the upper border of the testis.

on the right side of the body and causes an oval swelling parallel to and directly above Poupart's ligament. It does not project much from the surface and some of the sac may pass into the scrotum or labium, so that a groove appears between the two parts of the hernia.

In the second or subcutaneous variety the sac lies between the external oblique aponeurosis and the skin. The swelling has the same position as in the first form, but there is more projection from the surface.

In the third variety, or properitoneal hernia, there is almost always a part of the sac in the labium or scrotum (Eccles). It is seldom recognized except when strangulated or during radical cure operation.

Unusual Contents of Inguinal Herniæ.—*Hernia of the Bladder.*—This occurs oftener in connection with an inguinal, than in femoral hernia.

FIG. 292.—METHOD OF PALPATING THE SPERMATIC CORD IN ORDER TO MAKE THE DIAGNOSIS OF COMPLETE OBLIQUE INGUINAL HERNIA AFTER REDUCTION OF THE CONTENTS OF THE SAC. (See text.)

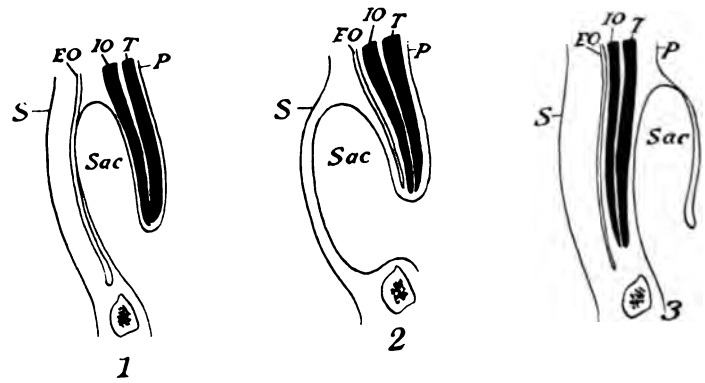


FIG. 293.—VARIOUS FORMS OF INTERSTITIAL HERNIÆ.

1, Subaponeurotic; 2, subcutaneous; 3, properitoneal (Eccles). *S*, Skin; *EO*, external oblique aponeurosis and muscle; *IO*, internal oblique muscle; *T*, transversalis muscle; *P*, peritoneum.

The most frequent variety is where the peritoneum covering the bladder forms a part of the sac.

A diagnosis may be made before operation if the patient gives the

history of the tumor disappearing during micturition, and if when pressure is made over it, the patient experiences a desire to urinate, or if the act of micturition ceases suddenly and begins again as soon as the hernial swelling is compressed.

Vermiform Appendix.—The presence of this structure cannot be recognized before operation unless it should become inflamed or strangulated. The symptoms of the latter are less marked than in a strangulation of the intestine proper.

Ovary.—Before puberty its presence may be suspected if an oval, firm, freely movable tumor be found in the inguinal canal or just external to it. Later in life the ovary can only be recognized before operation if a firm body is found in the hernial sac, which swells and becomes quite tender during menstruation.

FIG. 204.—INGUINAL HERNIA WITH UNDESCENDED TESTIS.

Cecum.—Especial attention is called to right-sided inguinal hernia in which the cecum alone, cecum and appendix together, or finally the appendix alone, form a portion of the wall of the sac. Such cases cannot be recognized before operation.

Ureter.—A few cases have been described in which the ureter was contained in the sac.

1. **Differential Diagnosis of Inguinal Hernia in the Male.**—1. *When Reducible and Complete.*—(*a*) From femoral hernia the following table will best illustrate the chief points of difference:

INGUINAL.	FEMORAL.
1. Emerges on inner side of pubic spine.	1. Emerges on outer side of spine.
2. Inguinal canal filled and pubic spine obscured, when descended.	2. Inguinal canal empty and pubic spine to be felt.
3. Easily recur after reduction.	3. Do not so easily recur.
4. Impulse felt above Poupart's ligament.	4. Impulse below Poupart's ligament.

(*b*) From a congenital or acquired hydrocele and from an undescended testis lying just outside of the external abdominal ring.

In the last named condition the testis of the corresponding side is felt, just beneath the external abdominal ring (Fig. 273), as a firm elastic body a little smaller than the normal testis. There is no impulse on coughing and the swelling cannot be reduced. Not infrequently a hernia is associated with this condition, so that a swelling is felt above the testis, which emerges from the inguinal canal on coughing and disappears upon manipulation or upon lying down.

(*c*) The following table shows the differentiation of a congenital hydrocele, and acquired hydrocele and a reducible inguinal hernia (see Figs. 287, 280, 295):

	Complete Inguinal Hernia (Reducible).	Congenital Hydrocele.	Acquired Hydrocele.
1. Location.....	Swelling continuous with inguinal region.	Same as in hernia.	Swelling terminates at upper end of scrotum; can feel cord above tumor (Fig. 292).
2. Impulse.....	Distinct on coughing.	No impulse.	No impulse.
3. Translucency....	Not translucent, as a rule. Rarely so, in children (Fig. 288).	Translucent.	Translucent (Fig. 284) unless greatly thickened sac.
4. If reduced.....	Feel gurgling if contains intestine, reappears rapidly on coughing.	Reduction very slow. Reappears slowly.	Cannot be reduced.
5. Relation to testis and cord.....	Lies above or in front of testis (see Fig. 296) and in front of cord.	Same as in hernia.	Lies in intimate relation to testis, latter felt usually below and behind tumor.
6. Palpation and percussion.....	Soft semi-elastic; dull if omentum; tympanitic if intestine.	Harder and more tense; dull on percussion.	Pear-shaped swelling; harder and tense; dull on percussion.

2. *When Complete and Irreducible.* The following conditions must be considered in making a diagnosis:

In the male:

(*a*) Hydrocele of the tunica vaginalis (acquired hydrocele).
(*b*) Hydrocele of the cord (encysted hydrocele—Fig. 295).
(*c*) Hematocele.
(*d*) Enlargements of the testis.

In the female:

(*a*) Hydrocele of the canal of Nuck.
(*b*) Hydrocele of the hernial sac.

The chief differential points are considered in the accompanying table:

	Complete Irreducible Inguinal Hernia.	Hydrocele of the Tunica Vaginalis.	Enlargements of Testis.
Inspection.....	Tumor extends through external ring into inguinal canal.	Tumor terminates below external ring.	Same as in hydrocele.
Palpation.....	Expansile impulse on coughing. Feels soft if intestine; firmer if omentum.	No impulse. Feels tense and elastic.	No impulse. Firm, may be irregular.
Percussion.....	Tympany, if intestine.	Dullness.	Dullness.
Relation to testis....	Testis is below and behind tumor.	Testis cannot be distinctly felt.	Can outline enlargement of body or epididymis.
Translucency.....	Negative except rarely in young children (Fig. 288).	Positive unless tunica greatly thickened.	Negative.

A *hematocele* gives the history of trauma or syphilis, and is not translucent. In an *encysted hydrocele of the cord* one can often palpate the nodules and can ascertain their attachment to the cord.

In a hydrocele of a hernial sac the tumor can be caused to gradually disappear by gentle manipulation and elevating the pelvis.

In a hydrocele of the canal of Nuck, which is quite rare, the diagnosis can only be made if there is distinct absence of impulse.

3. *When Irreducible and Incomplete.—In the Male:*

(*a*) From a retained inguinal testis.

(*b*) From various causes of enlargement of the spermatic cord (encysted hydrocele, lipoma).

(*c*) From enlarged and inflamed lymph-nodes.

(*d*) From a lipoma of the groin.

(*a*) An inguinal testis can be readily recognized by its size and consistency. One should palpate the scrotum as a matter of routine in order to ascertain whether one or both testes have failed to descend.

(*b*) From various sources of enlargement of the spermatic cord. An encysted hydrocele is tense and elastic and is intimately connected with the cord. A lipoma of the cord is rare. It feels soft and doughy and may be lobulated.

(*c*) Enlarged and inflamed inguinal lymph-nodes. These are quite superficial and are tender to the touch. There is often redness of the overlying skin and distinct fluctuation present. In doubtful cases search should be made for a primary source of infection in the external genitalia, lower portion of the rectum and vagina, and lower half of abdominal wall.

In the Female:

(*a*) Hydrocele of the canal of Nuck is uncommon. In many cases

it is present as a reducible swelling in the inguinal region for a long period, and then suddenly cannot be displaced. It may have the latter property of irreducibility from the first in some cases.

It may be a unilocular or bilocular sac. At times it may become in-

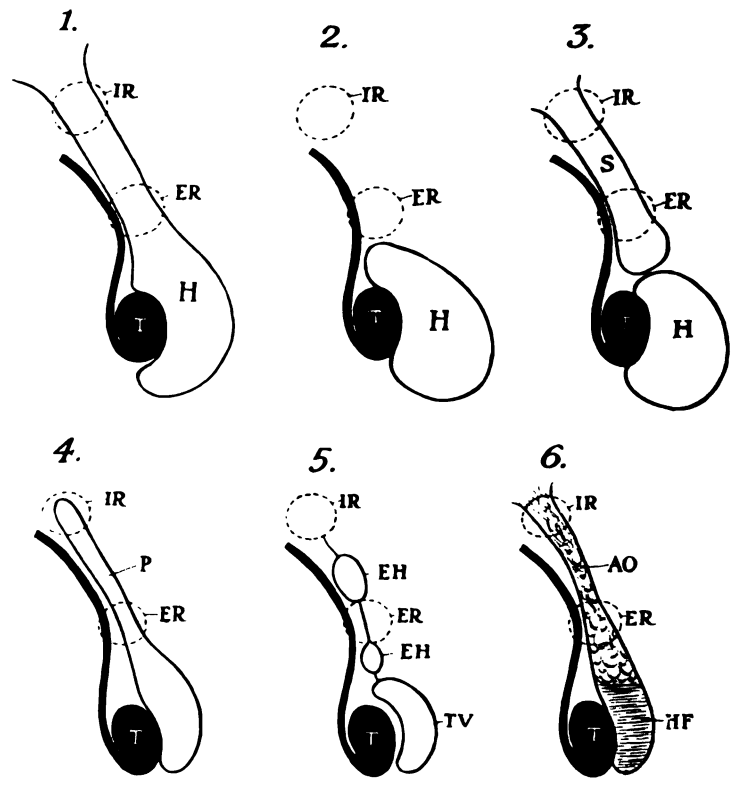


FIG. 295.—VARIOUS FORMS OF HYDROCELE.

IR, Internal abdominal ring; *ER*, external abdominal ring; T, testis and epididymis, shown in black. 1. Congenital hydrocele. The cavity of the hydrocele sac (H) communicates directly with the peritoneal cavity. 2. Typical form of acquired hydrocele: H, Distended tunica vaginalis. 3, Acquired inguinal hernia and acquired hydrocele: S, Sac of hernia; H, hydrocele sac. 4, Hydrocele of funicular process. The process is closed at the internal abdominal ring, but is continuous below with the tunica vaginalis: P, Represents that portion of the sac lying within inguinal canal. 5, Hydrocele of cord: EH and EH, placed respectively within the inguinal canal and just outside of the external ring, represent the two loculi of a hydrocele of the cord; TV, normal tunica vaginalis. 6, Hydrocele of a hernial sac. AO, Adherent omentum; HF, hydrocele fluid in lower portion of sac.

flamed and simulate a strangulated hernia, being accompanied by severe pain, tenderness, and vomiting.

FEMORAL HERNIA.

A femoral hernia has the following clinical characteristics: The swelling in the majority of cases (Fig. 299) can be seen and felt as lying below or in front of Poupart's ligament and over the inner side of the

front of the thigh. The impulse on coughing and the neck of the sac can be felt as lying on the outer side of the pubic spine. The swelling is not as apt to occur so easily when reduced, and after reduction one can feel the pulsation of the femoral artery. The inguinal canal is empty and no impulse on coughing can be felt after invaginating the scrotum and inserting the index-finger into the external abdominal ring (Fig. 289).

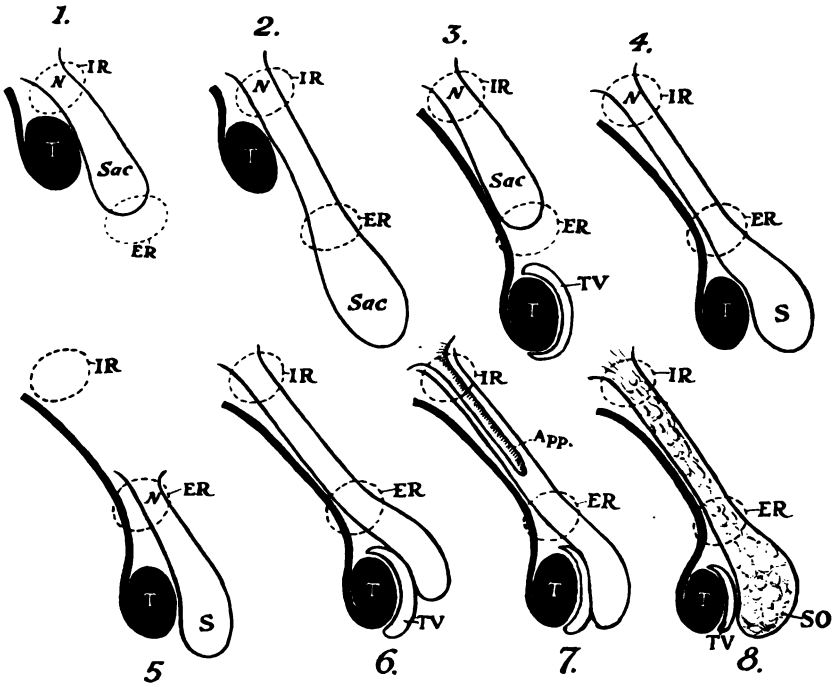


FIG. 296.—CONDITIONS TO BE CONSIDERED IN DIFFERENTIAL DIAGNOSIS OF HERNIA AND HYDROCELE.

T, Testis; N, neck of hernial sacs; IR, internal abdominal ring; *ER*, external abdominal ring; TV, tunica vaginalis; App, appendix vermiformis; SO, omentum adherent to sac. 1, Congenital incomplete inguinal hernia associated with non-descent of testis. 2, Complete congenital inguinal hernia associated with non-descent of testis. 3, Incomplete acquired inguinal hernia with normal testis. 4, Complete congenital hernia with normal descent of testis. 5, Direct inguinal hernia with normally descended testis. 6, Acquired inguinal hernia with normal descent of testis. 7, Acquired inguinal hernia showing appendix as one of the contents of sac. 8, Acquired inguinal hernia with adherent omentum.

In some cases of femoral hernia the swelling ascends and either lies in front of the inner half of Poupart's ligament or it passes upward and outward toward the anterior superior spine of the ilium. In many of these latter two aberrant varieties of femoral hernia, a differentiation from an inguinal hernia cannot be made except at the time of operation.

It was formerly thought that a femoral hernia was rare in men, and that an inguinal hernia was similarly infrequent in the female. The

FIG. 307.—ONE OF THE STEPS IN MAKING A DIFFERENTIAL DIAGNOSIS BETWEEN AN ACQUIRED HYDROCELE AND A HERNIA

Grasping the spermatic cord between the index-finger and thumb to show that the scrotal tumor does not pass through the external abdominal ring. The hydrocele which was present in this case on the right side remains as a pear-shaped swelling, entirely below the fingers grasping the cord.

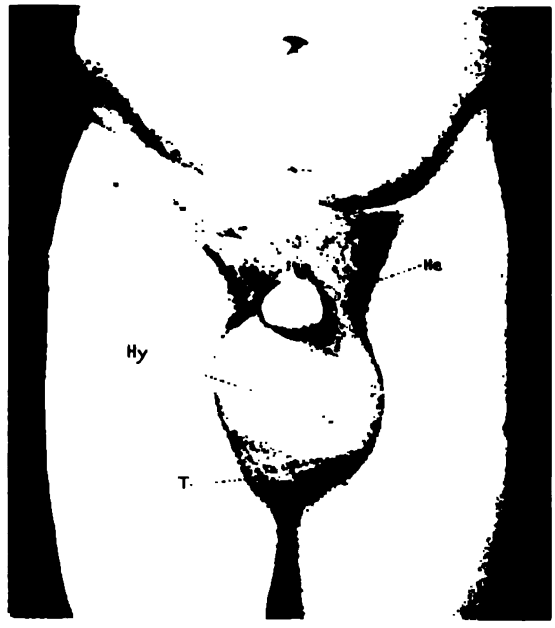


FIG. 308.—HERNIA AND HYDROCELE IN THE SAME PATIENT

Hy, Hydrocele; T, testis pushing the testes (T) downward and behind it; He, left indirect complete or scrotal hernia. (See text.)

foregoing statement has been proved by many clinical observations to be incorrect. The two varieties may coexist in the same individual.

A femoral hernia, like an inguinal hernia, may be reducible and irreducible. It is more apt to contain omentum than the inguinal, and hence is more often irreducible. The following combinations may exist (see Fig. 300):

1. It may be completely reducible.
2. It may be possible to reduce the greater portion of the tumor and

FIG. 299.—INGUINAL AND FEMORAL HERNIÆ ON THE SAME SIDE.

I, Inguinal hernia, of the complete or scrotal type, which can be followed upward to where it enters the internal abdominal ring at the level of the middle of Poupart's ligament; F, femoral hernia. The depression between these two varieties of hernia corresponds to Poupart's ligament.

then a doughy swelling remains which is usually a subperitoneal lipoma (Fig. 300) attached to the fundus of the sac.

3. It may be completely irreducible.

The three chief conditions from which a reducible femoral hernia must be differentiated are: (1) Incomplete reducible inguinal hernia; (2) psoas abscess; (3) a varicose dilation of the internal saphenous vein just before it enters the saphenous opening.

The first three are given in the accompanying table:

	Reducible Femoral Hernia.	Incomplete Reducible Inguinal Hernia.	Varicosity of Saphenous Vein.	Psoas Abscess.
1. Location of swelling.....	Below Poupart's ligament.	Above Poupart's ligament.	Below Poupart's ligament and along course of saphenous vein.	Below Poupart's, but mass also to be felt by deep palpation over Poupart's ligament.
2. Impulse.....	Distinct, and felt below Poupart's ligament.	Distinct and felt above Poupart's ligament.	Indistinct and disappears rapidly; more of a thrill.	Indistinct and only when lying down.
3. Percussion....	Dull, if omentum; tympanitic, if intestine.	Same as in femoral.	Dull.	Dull.
4. Other signs..	Reappears after reduction; when coughs. Reduction backward and upward.	Reappears after reduction (outward, upward, and backward); when patient coughs.	Marked enlargement of entire internal saphenous vein.	Kyphosis and rigidity of spine. Hip flexed.

Occasionally a femoral hernia will contain the urinary bladder. The diagnosis[1] is rarely made before operation, although suspicion should

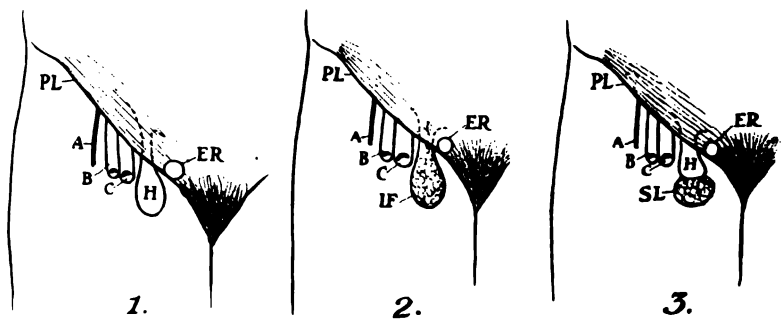


Fig. 300.—Normal and Complicated Femoral Hernia.

PL, Poupart's ligament; ER, External abdominal ring; A, anterior crural nerve; B, femoral artery; C, femoral vein; H, hernial sac. 1, Most common form of femoral hernia. The sac lies to the outer side of the external ring and below Poupart's ligament. 2, Irreducible form of femoral hernia, due to adhesions of omentum to interior of sac. 3, A reducible femoral hernial sac to which is attached an irreducible subperitoneal lipoma.

be directed to this possible contents when urinary symptoms appear in connection with a femoral hernia. The cystoscope may be of aid in showing the relationship of the bladder to the hernia.

An irreducible femoral hernia must be differentiated from (1) an enlargement, of either an acute or a chronic nature, of the lymph-nodes lying over the saphenous opening; (2) from a lipoma; (3) aneurysm of the femoral artery.

1. Inflamed or enlarged lymph-nodes lie quite superficially. If acutely inflamed, there are no symptoms of disturbance in the alimentary canal, such as nausea, vomiting, tympanites, etc., as would be the

[1] Karewski: "Archiv f. klin. Chir.," Bd. lxxv.

case in an inflamed or strangulated femoral hernia. Fluctuation is often quite distinct and a primary focus of infection can be found by an examination of the lower extremity (toes, heel, sole of foot, leg, knee, etc.). The enlarged nodes can be moved upon the underlying tissues, while in an irreducible femoral hernia one can always feel (except in very stout persons) the neck of the sac.

2. A femoral lipoma has no impulse; it is often lobulated, and lies quite superficially. It must not be forgotten, however, that a large lipoma may be attached to an irreducible femoral hernial sac. Under these circumstances a differentiation is impossible before operation.

FIG. 451.—DOUBLE FEMORAL LIPOMATA SIMULATING FEMORAL HERNIÆ (Eccles).

3. An aneurysm shows a distinct thrill, expansile pulsation, and a rough systolic bruit.

In inflammation of the iliopsoas bursa there is pain on movement of the hip and the swelling and tenderness lie quite deeply.

UMBILICAL HERNIA.

There are three varieties of this form of hernia: (*a*) the congenital, (*b*) the infantile, and (*c*) the adult.

Congenital Umbilical Hernia.—This occurs as the result of the non-coalescence of the two lateral halves of the abdominal wall. The most important form of a congenital umbilical hernia is that in which a coil of small intestine or Meckel's diverticulum projects through the base or root of the umbilical cord. If the latter is tied too close to the

body, the knuckle of intestine may be cut through and a septic peritonitis result. It is almost impossible to recognize this form unless the base of the cord looks broader than normal and can be reduced in size by taxis, the enlargement disappearing with a gurgle.

The other two forms of congenital umbilical hernia are not difficult to recognize. In one form a large swelling is found in which the presence of viscera can be seen through the thin translucent membrane which covers it.

FIG. 492.—VIEW OF AN ADULT UMBILICAL HERNIA IN THE EARLIEST STAGE OF ITS DEVELOPMENT.

This illustration was made while the patient was lying down. The arrow points to the prominence situated just above the umbilicus proper (see text). The photograph was made while the patient was coughing, showing the umbilical hernia at its maximum size.

The umbilical cord is found at the summit of the swelling. The swelling usually contains only coils of intestine, but other viscera may be present. In the third form, which is quite rare, there is a complete eventration and the prolapsed viscera lie exposed without even a membranous covering.

Infantile Umbilical Hernia.—These usually present themselves in infants, but may be found even in young adults.

Examination of the umbilical region reveals a conical swe[illegible]er

which there is a loose fold of skin. The protrusion is only noticeable when the child coughs or strains. When the swelling is reduced the firm edges of the circular umbilical ring can be felt by inserting the little finger.

Umbilical Hernia in Adults.—Clinically umbilical hernia in adults appears either (*a*) as a small tumor usually lying just above the umbilicus (Fig. 302), or (*b*) as a larger one which is easily recognized and which pushes the cutaneous umbilicus forward (Fig. 303).

FIG. 303.—SIDE VIEW OF A CASE OF UMBILICAL HERNIA.

The coils of intestine and omental contents of this sac were adherent to the interior of the sac, so that symptoms of incarceration would appear from time to time.

Both forms are more apt to occur in stout persons, but the smaller variety may occur even in lean individuals and be the source of much discomfort. Such small umbilical herniæ may give rise to recurring abdominal pain and various dyspeptic symptoms, and, the hernia being overlooked, the patient is often wrongly treated (D. D. Stewart). The best method of examination for both this variety of adult umbilical and for epigastric herniæ is to inspect and palpate the median line of the abdomen while the patient coughs, first while standing up (Fig. 182) and then upon lying down. In many of the cases the hernia is associated with a properitoneal lipoma, as in the femoral herniæ. Under these circumstances one sees a protrusion (even if only very slight) upon coughing and feels an impulse. Upon further examination it is found that the swelling does not disappear entirely upon manipulation or upon lying down, but that a soft, often lobulated mass can

be felt. The latter is the small properitoneal lipoma attached in the sac.

These small umbilical herniæ must be differentiated from fatty tumors of the linea alba. This can be done by the absence of an impulse upon coughing and the fact that manipulation or posture, such as lying down, does not cause the tumor to disappear.

The larger umbilical herniæ present no difficulties of diagnosis. The swelling is rounded or transversely oval and often hangs down toward the symphysis (Fig. 303). The swelling is more often irreducible than the opposite. If the former is the case the tumor feels doughy and lobulated and is dull on percussion. The contents are usually composed of omentum firmly adherent to the sac and coils of intestine. Incarceration and strangulation of these larger umbilical herniæ are not infrequent complications.

FIG. 304.—METHOD OF PALPATING AN EPIGASTRIC HERNIA.

The finger-tips of the examiner should be placed successively upon different points in the linea alba from the ensiform downward, and the patient instructed to cough.

If symptoms of intestinal obstruction occur in stout persons one should never fail to examine the umbilical region carefully.

The characteristics of these complications (incarceration and strangulation) have been referred to on page 464.

VENTRAL HERNIÆ.

These occur as an acquired condition, usually in the linea alba or linea semilunaris. They may occur spontaneously, or follow an operation or a trauma such as a penetrating or crushing wound. I have described a case[1] of the traumatic non-penetrating variety in which a swelling with unbroken skin appeared within a short time

[1] "Annals of Surgery," 1904.

over the crest of the ilium in a patient who had been crushed between two cars. The abdominal muscles and peritoneum had been torn from the crest of the ilium. The ordinary spontaneous variety of ventral hernia may be found above or below the umbilicus. When they occur in the median line above the umbilicus they are spoken of as epigastric herniæ. They are often the cause, like the small umbilical herniæ, of recurrent abdominal pain and symptoms of digestive disturbance. The diagnosis of these epigastric as well as of the other forms of ventral herniæ is not difficult. In some cases there is no visible swelling and a diagnosis can only be made by passing the fingers along the median line and the semilunar line while the patient coughs. The characteristic impulse and the appearance of a swelling enable one to make the diagnosis. These ventral herniæ may attain such a large size that practically all of the hollow viscera and omentum are contained in them. In very stout persons an enormous overhanging mass of fat will at first sight simulate such a hernia (Fig. 290).

In every case presenting symptoms of chronic gastritis, gallstones, or ulcer of the stomach one should examine for the presence of an epigastric hernia.

A hernia following a laparotomy can be recognized from the history, the scar, and the signs characteristic of all reducible herniæ, viz., a swelling which disappears, often with a gurgle, upon manipulation or upon lying down, and reappears with an impulse upon standing up or after exertion such as coughing, etc.

RARER FORMS OF HERNIÆ.

Obturator Hernia.—This form can seldom be recognized until symptoms of strangulation appear. The protrusion occurs through the obturator foramen and can occasionally be felt externally just below the pubes on the inner side of the femoral vessels. It may also cause pain, which is referred to the knee along the distribution of the obturator nerve. If strangulation occurs, the condition must be differentiated from rheumatism by the absence in the latter, of symptoms of intestinal obstruction, and from pelvic peritonitis, by the bimanual examination of the pelvis. Obturator herniæ are most apt to occur in elderly females.

Diaphragmatic Hernia.—This has been previously described in connection with injuries of the thorax (page 212).

Lumbar Hernia.—This may occur anywhere behind the linea semilunaris and between the last rib and crest of the ilium. The herniæ may be congenital or acquired, the latter often being b[illegible]

The acquired form may be either spontaneous or traumatic. The former usually protrude through the triangle of Petit, just below the twelfth rib, as a swelling which has all the signs just referred to as typical of a reducible hernia. One must differentiate the spontaneous variety from a lipoma, and from a cold abscess due to disease of the spine.

The traumatic variety may either follow an operation upon the kidney or some crushing injury, such as described under traumatic ventral hernia.

The diagnosis does not differ from that of the spontaneous variety.

Sciatic Hernia.—This occurs through the sacrosciatic foramen, forming a swelling in the gluteal region. Very few cases have been recorded of this variety of hernia. When the hernia is small it may escape recognition unless a careful examination for such symptoms as pain over the gluteal region be made. If the hernia is large it gives rise to a distinct gluteal swelling with a marked impulse on coughing and reducibility with a gurgling sound if intestine is present in it. It must be differentiated from an abscess due to hip disease, from a lipoma, and from an aneurysm.

CHAPTER V.

THE EXTREMITIES.

INJURIES OF THE SOFT TISSUES, BONES, AND JOINTS.

In attempting to make a diagnosis as to the nature of injuries received as the result, either of a recent accident, or of one sustained at some previous period, the following possibilities must be borne in mind, and each one eliminated by a process of exclusion, based upon a thorough examination and history of the case.

These possible injuries and their complications are:

INJURIES OF THE SOFT PARTS.

Location.	Nature.	Possible Complications or Results.
1. Skin and subcutaneous tissue.	(*a*) Penetrating wounds; lacerated, punctured, incised, gunshot.	(*a*) Infection with ordinary pyogenic organisms (streptococci and staphylococci).
	(*b*) Non-penetrating wounds or contusions.	(*b*) Tetanus.
		(*c*) Erysipelas and erysipeloid.
		(*d*) Infection with gas-producing bacilli.
		(*e*) Anthrax.
2. Muscles	Contusions, penetrating wounds, rupture of muscles.	Traumatic myositis, myositis ossificans. Loss of function.
3. Tendons and tendon-sheaths	Lacerated or incised wounds. Rupture of tendon, dislocation of tendons.	Infective tenosynovitis, ganglion. Loss of function.
4. Bursæ	Contusions. Penetrating wounds.	Acute suppurative and non-suppurative bursitis.
5. Blood-vessels	Penetrating wounds or contusions of arteries or veins.	Phlebitis. Gangrene of extremities. Ulcers (trophic). Traumatic aneurysms.
6. Nerves	Contusions or penetrating wounds of nerve-trunks or filaments.	Neuritis. Paralysis of motion or sensation or both.

INJURIES OF THE BONES AND JOINTS.

Location.	Nature.	Complications.
1. Bones	Contusions or penetrating wounds of periosteum. Simple or compound fractures.	Periostitis or necrosis of bone. Infection. Injury of nerve. Injury of vessels. Gangrene or aneurysm. Coxa vara traumatica.
2. Joints	Sprains. Penetrating wounds. Dislocations, simple and compound.	Septic arthritis. Injury to cartilages or ligaments. Paralysis of nerves.

INJURIES OF THE SOFT PARTS.

The most important points to be determined in the examination of an injury of the extremities are: (*a*) the location of the injury; (*b*) its nature or extent; (*c*) whether complications exist or not. In order to be able to answer these, a careful history must be taken of the manner in which the accident occurs, next the physical examination of the part involved, as well as the observation of the general condition.

Injuries of the skin consist of either simple or complicated wounds. In the simple variety there is an injury of the skin and subcutaneous tissues alone, either (*a*) in the shape of a lacerated, incised, punctured, or gunshot wound, often called a penetrating wound, or (*b*) a collection of blood in the subcutaneous connective tissue of greater or less extent, called a non-penetrating wound or contusion (bruise).

In the penetrating wounds of the simple variety, there is no difficulty in making a diagnosis. The edges of the wound gape to a variable extent and the subcutaneous fat may prolapse. The amount of bleeding varies according to the vessels severed. If from an artery, it occurs intermittently and is bright red in color. If from a vein, the flow is continuous and of a darker color. If from the capillaries, called parenchymatous hemorrhage, it is steady in character, but the amount is not so great as is that from an artery or vein.

All the penetrating wounds of the skin may be associated with more or less contusion, *i. e.*, laceration of the soft parts with hemorrhage into them, or the latter condition, known as a contusion, may exist without any such penetrating wound.

A *simple contusion* causes a painful swelling of the skin which may either be quite circumscribed or occupy a considerable area. Discoloration of the skin often occurs at a very early period, or may not appear until after some days, the skin becoming at first bluish, then yellowish in color.

Both penetrating and non-penetrating wounds of the skin may be complicated in the following ways: (*a*) There may be an associated injury of the other structures in the limb. (*b*) The injury may be complicated by symptoms of shock or of general anemia from hemorrhage. (*c*) One of the so-called accidental wound infections or other sequelæ may be complicating the clinical picture.

Signs of Injury of Other Soft Parts.—These may often be ascertained by inspection of the wound. In some it will be necessary either to retract the edges or to secure the information through (*a*) the discovery of loss of function of a muscle, tendon, or nerve;

(*b*) through hemorrhage or gangrene resulting from injury of an artery or vein.

If it becomes necessary to examine a wound the utmost precaution should be taken to prevent infection. In the majority of cases the location of the wound in relation to important anatomic structures and the observation of loss of function will suffice, so that a direct inspection of the wound is rarely necessary for diagnostic purposes.

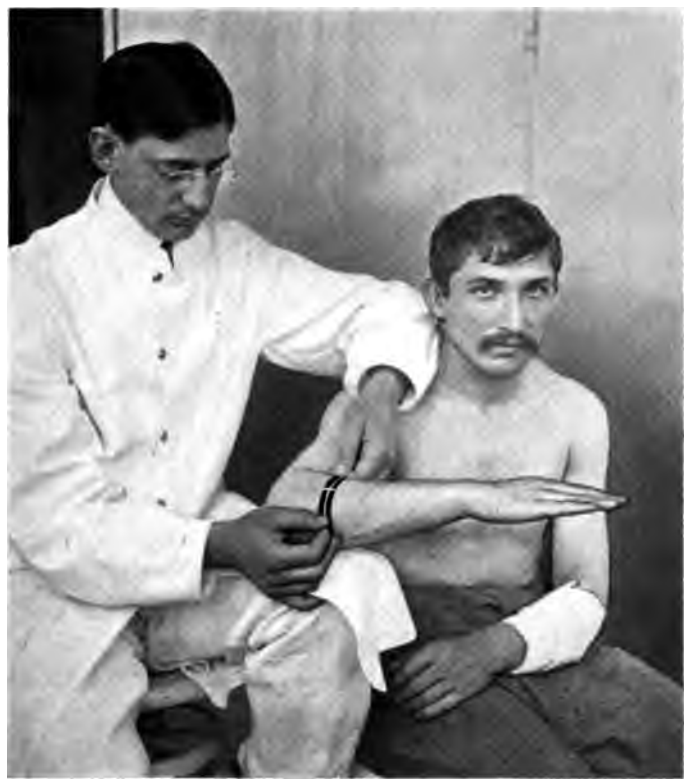


FIG. 305.—METHOD OF MEASURING THE FOREARM IN ORDER TO DETERMINE ATROPHY OF THE SAME. The patient may be examined while lying down. The point for measuring the circumference is at the level of the greatest amount of muscular development of the forearm

INJURIES OF MUSCLES, TENDONS, AND TENDON-SHEATHS.

Contusions of Muscles.—A contusion of a muscle may be suspected if there is inability to use the muscle combined with localized tenderness and pain shortly after the injury. A little later, such muscular injury can be suspected if there is rapid atrophy, as determined either by palpation or by the measurement of the circumference of the limb

and comparing it with that of the opposite one (Fig. 305). Such loss of function and atrophy of a muscle may be due to injury of the nerves supplying it or to non-use of the limb following bone or joint injuries. The latter are far more frequently followed by atrophy than is an ordinary contusion of a muscle.

FIG. 306.—METHOD OF MEASURING THE CIRCUMFERENCE OF THE ARM REGION PROPER, IN ORDER TO DETERMINE ATROPHY OF MUSCLES.

This may be performed either with the patient sitting up or lying down. In all of these measurements of the circumference of extremities one of the most accurate methods is to employ a steel tape-measure, and to take as the beginning-point some inch or centimeter measurement which is not too near the end of the tape, and to hold this point opposite some point to which the circumference of the arm may cause the examiner to stretch the tape-measure. The second point is noted, and the distance of the beginning of the tape-measure to the starting-point subtracted from it. For example, if the starting-point chosen was the mark at the end of the one-inch measure, and the second point after the circumference had been measured was eight inches, the circumference of the arm would be the difference, or seven inches.

Another sequel of a muscular contusion is the formation of bone in it, a condition known as *traumatic ossifying myositis* (myositis ossificans traumatica). This condition of ossification between or within the muscles may follow either repeated slight traumas or a single but severe one.

The former are usually associated with certain occupations in which

the muscles are subject to frequent injury, as the rider's bone in the adductor longus muscle of cavalry riders.

In both varieties of cases there is to be felt in the muscles a hard bony mass whose formation can be directly traced to the trauma. The presence of the osseous deposit can be confirmed by an *x*-ray examination. In some cases it is necessary to exclude a periosteal sarcoma (see page 653) from the area of myositis ossificans in a skiagraph.

Ruptures of Muscles and Tendons.—These may occur in any of the muscles or tendons of the extremities, but are more frequent in certain ones. Pure muscular ruptures occur oftenest in the biceps of the arm and in the quadriceps extensor of the thigh. Rupture of tendons occurs most frequently in the quadriceps extensor tendon, either above or below the patella. The tendo Achillis and the biceps brachii, either at its upper or lower ends, are next in frequency. These ruptures seldom occur as the result of external violence, but almost always from a violent contraction during unusual exertions.

FIG. 307.—FLEXION CONTRACTURE OF ALL OF THE FINGERS OF THE HAND.
Caused by a crushing injury which opened up the flexor tendon-sheaths.

These ruptures of muscles or tendons may be recognized by the sudden severe pain in the affected muscle or tendon, inability to use it, and the palpation of a gap at the point of rupture.

In the case of muscular ruptures this gap or depression is marked on either side by a prominence formed by the torn ends of the muscle. This gap is soon filled with a clot and becomes less prominent.

In tendon rupture, especially of the lower end of the biceps, ligamentum patellæ, or of the tendo Achillis the gap is very distinct and can be readily felt owing to the superficial positions of these tendons.

Tendons may be pulled away from their points of origin or attachment by violence such as occurs when a hand or foot or the entire extremity is torn off from the remainder of the body. The tendo Achillis

and ligamentum patellæ are often torn from their respective attachments, by sudden and violent muscular movements.

Dislocations of Tendons.—The only tendons which have so far been described as subject to this injury are those of the peroneal muscles and long head of the biceps. The condition can be recognized clinically if during contraction of the tendon the latter is felt as if springing out of its normal location.

FIG. 308.—DIRECT POSTERIOR VIEW OF A CASE OF OLECRANON BURSITIS.

Note the swelling over the olecranon process.

FIG. 309.—LATERAL VIEW OF CASE OF OLECRANON BURSITIS.

The white arrow points to the prominent olecranon bursa.

Herniæ of Muscles.—Either following severe contusions of the muscles with tears of the fasciæ or after penetrating wounds of the latter, a localized swelling appears during contraction and vanishes during relaxation of the muscle. After disappearance of the swelling a distinct gap can be felt in the fascia through which the muscular hernia occurred. This injury is most apt to take place in the muscles of the thigh and leg and can be readily recognized.

Penetrating Wounds of Muscles, Tendons, and Tendon-sheaths.—Penetrating wounds of muscles often occur as a part of complicated wounds of the skin, and can be readily recognized upon inspection of the cut edges or through loss of function of the muscles. If the wounds become infected, a purulent myositis may follow with sloughing of some of the muscle fibers. Tendon injuries occur oftenest on the anterior or posterior surfaces of the wrist or around the ankle and foot. The diagnosis may be made, either from inspection of the wound and observing the presence of the cut ends or by testing for loss of function in the corresponding parts, *e. g.*, inability to flex or extend the fingers or toes.

FIG. 310.—BURSITIS OF METACARPO-PHALANGEAL BURSA.
B. Points to prominence due to bursa.

A partial severing of a tendon is of no significance unless the wound is quite deep. Wounds of the hand in which the tendon-sheaths have been opened with or without laceration of the tendons are of great importance for two reasons: (*a*) the possibility of infection spreading to the forearm; (*b*) the fact that the wound in the tendon-sheath is very prone to adhere to the skin wound, causing serious cicatricial deformities (Fig. 307).

Injuries of the Bursæ.—These may occur either in the form of contusions or of penetrating wounds. In contusions of the bursæ there is rapid swelling, local tenderness, and pain. Suppuration may take place without any communication with the overlying skin being present.

Before infection has occurred, the diagnosis may be made by noting the presence of a painful swelling, which usually fluctuates dis-

tinctly, situated at the locations of the more superficial bursæ, viz., the olecranon (Fig. 308), metacarpophalangeal (Fig. 310), prepatellar, less often the subdeltoid, ischiadic, tendo Achillis, and trochanteric bursæ.

Not infrequently the skin around the swelling shows evidences of extensive contusion.

FIG. 311.—DORSAL VIEW OF CASE SHOWN IN FIG. 310 (LATERAL VIEW), OF BURSITIS OF THE METACARPO-PHALANGEAL BURSA OF INDEX-FINGER.

If infection occurs after a contusion or a penetrating wound of a bursa, the swelling becomes very tender, there is local redness, heat, and infiltration of the overlying skin, as well as the general signs of infection, such as elevation of temperature and pulse-rate, leukocytosis, etc.

A knowledge of the location of the more common bursæ is of great importance clinically (Fig. 312).

Injuries of the deeper bursæ, such as the subdeltoid, iliopsoas, or semimembranous, may, if they suppurate, play a rôle in spreading the infection to the large joints with which they often communicate.

INJURIES OF BLOOD-VESSELS.

Injuries of Arteries.—These may occur in any of the arteries of the upper and lower extremities as the result (*a*) of penetrating wounds with sharp instruments, such as a knife, razor, bayonet, etc. (*b*) In severe contusions of a limb, when an artery like the femoral or brachial is firmly compressed against the pubes or humerus respec-

tively. (*c*) As a complication of gunshot wounds or explosion of shells, etc. (*d*) In extensive crushing injuries of a limb. (*e*) As the result of a simple or compound fracture, a fragment either penetrating the vessel or the wall becoming necrotic from pressure of the displaced fragments upon it (Fig. 313).

The **diagnosis** of an arterial injury is based upon (*a*) certain primary symptoms which immediately follow the injury; (*b*) other signs appearing at a later period, so-called secondary signs. The symptoms indicating an arterial injury which occur *immediately* depend upon whether the vessel has been completely or partially severed and whether the hemorrhage has ceased spontaneously.

If one can observe the characteristic red spurting of an arterial hemorrhage, the diagnosis is easy. The cases are rarely seen at such a time, the bleeding, if it has been severe, either having caused speedy death, or the extreme anemia occasioned by great loss of blood results in such slowing of the heart's action, that only a slight flow takes place from the end of the torn artery.

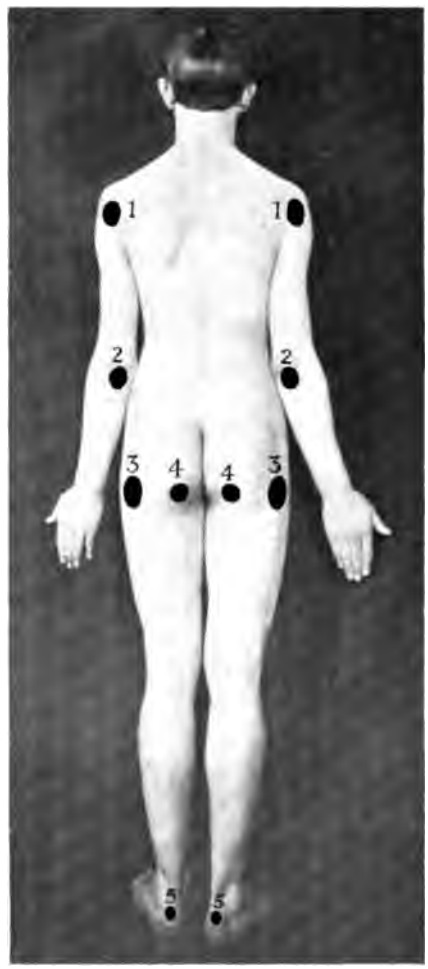


FIG. 312.—LOCATION OF VARIOUS BURSÆ.

1, Subdeltoid; 2, olecranon; 3, trochanteric; 4, ischial; 5, bursa beneath tendo Achillis at its insertion in the os calcis.

The majority of cases are seen at a time when the hemorrhage has been temporarily checked, either through the feeble action of the heart following the severe loss of blood or as a result of a plugging of the tear in the artery by a thrombus or as a result of retraction of the vessel.

If a large wound exists in which the torn vessel can be seen, the **diagnosis** is also easily made.

Usually a diagnosis depends upon the *recognition of other primary and secondary signs.* The remaining primary signs are: (*a*) the absence of a pulse in the peripheral vessels of the cold and pale limb; (*b*) the presence of a rough rasping murmur, synchronous with the pulse and resulting from the projection of a thrombus into the lumen; (*c*) the appearance of a large hematoma in the neighborhood of the injured vessel accompanied by signs of severe anemia.

The so-called *secondary or late evidences of an arterial injury* are the appearance (*a*) of a traumatic or false aneurysm; (*b*) of beginning gangrene of the limb; (*c*) the occurrence of severe secondary hemorrhage, usually about the sixth to ninth day.

Traumatic or *false aneurysms* are more apt to follow stab than gun-

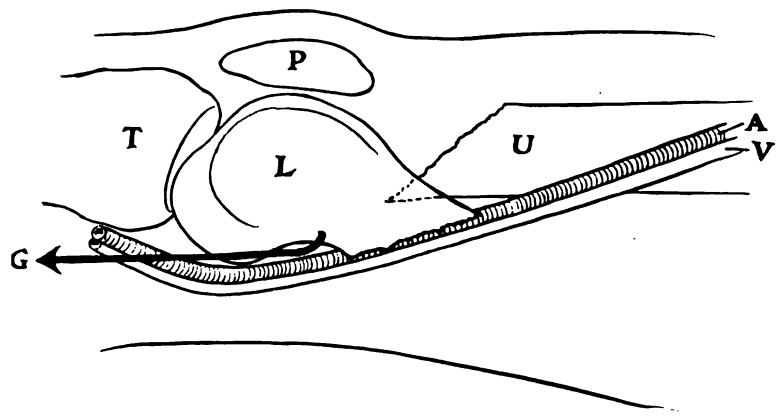


FIG. 313.—SUPRACONDYLOID FRACTURE OF FEMUR.

The illustration shows how the gastrocnemius muscle, whose action is represented by the black arrow terminating at the letter G, causes the lower fragment to be pulled downward and backward, impinging upon the popliteal artery and vein, and resulting in gangrene of the leg in some instances.

shot wounds. Clinically they can be recognized by the appearance of a swelling in the vicinity of the original wound or proximal to it (Fig. 314), which shows a distinct expansile thrill and a blowing, often rough, systolic murmur. At a later period, varicosities of the superficial veins become very marked. If both artery and vein are injured simultaneously, and this is not infrequent, the symptoms in the early period do not differ, as a rule, from those of injury of the artery alone, except by an increased amount of edema of the limb. Later on, this swelling becomes quite marked and is accompanied by other signs, such as a continuous murmur, which is transmitted in a proximal and distal direction in both artery and vein. There is frequently also distinct venous pulsation and the veins become varicose (Fig. 238).

The arteries most often injured are the subclavian, axillary, bra-

chial, and radial in the upper, and the femoral and popliteal in the lower extremity.

Injuries of the Veins.—With the exception of injuries of the larger venous trunks, these are of less importance and are rarer than the same conditions in the arteries. As in the case of the la ter, the diagnosis may be made from certain primary or immediate, and secondary or late signs. They may occur as the result of the same causes which were mentioned as producing arterial injury. In addition, the veins are often wounded during operations for the removal of tumors or enlarged lymph-nodes, and rarely during the performance of a herniotomy. The larger trunks most often injured are the subclavian, axillary, brachial, femoral, and popliteal. The ***primary signs*** of vein injury are: (*a*) Hemorrhage, which is seldom as great as after injury of the corresponding artery, but may be quite severe; it increases when the limb is held down. The blood is of a dark color and flows in a steady stream. (*b*) The entrance of air into the vessels. This rarely occurs in wounds of the veins of the extremities.

FIG. 314.—ANTERIOR VIEW OF PATIENT WITH TRAUMATIC ANEURYSM OF FEMORAL ARTERY AND SECONDARY ANEURYSM OF EXTERNAL ILIAC ARTERY.

(1) The black semicircle below this figure indicates the size of the iliac aneurysmal sac as palpated through the abdominal wall; (2) extent of sac of aneurysm in femoral artery; (3) wound of entrance of knife.

The ***late or secondary signs*** are (*a*) the formation of an arteriovenous or (*b*) of a varicose aneurysm, if the artery is simultaneously injured (page 496). These are usually the result of stab and gunshot wounds and only occur in the larger vessels of the extremities.

The symptoms of arteriovenous aneurysms vary somewhat according to the relations of the two vessels.

1. If there is a wide communication of an arterial aneurysm with the vein, the pulse is transmitted to the latter, gradually decreasing in intensity from the point of contact in both directions. In addition

to the systolic arterial, there is a continuous rough, sawing, venous murmur, often more marked during the diastole.

2. In an aneurysmal varix compression of the artery above the communication causes the sac to disappear, which is not the case in the first-named variety. There is considerable edema of the limb and marked varicosities.

3. If there is a direct narrow communication, between the artery and vein, the only sign is a continuous rasping murmur transmitted along the vein, which ceases when the artery is compressed.

Before leaving the diagnosis of vessel injury, it is desirable to refer briefly to the fact that apparently insignificant wounds, wherever situated, in the body of a class of persons suffering from a condition known as *hemophilia*, may bleed profusely and most persistently. This complication must always be borne in mind in cases of obstinate hemorrhage from comparatively insignificant wounds.

In addition to such unusual hemorrhage from wounds, whether operative or accidental, these individuals often have other symptoms of diagnostic value.

These latter are: (*a*) The occurrence of purpuric spots, petechiæ, or ecchymoses into, or of hematomata beneath the skin. (*b*) Hemorrhages from various mucous cavities, like the stomach or intestine. (*c*) The occurrence of multiple joint swelling as described on page 718.

INJURIES OF THE NERVES.

These may be partial or complete. The former are called *contusions* and the latter *lacerations or solution of continuity*. The nerves of the extremities belong to the class of mixed motor and sensory nerves, hence any injury will cause a disturbance of their function, which varies according to the degree of the injury.

The diagnosis may, in general, be made from the following specific signs:

1. Paresis or paralysis of the muscles supplied by the injured nerve or nerves. The paresis or paralysis will be either complete or incomplete, depending upon whether the affected muscle or muscles are supplied by the injured nerve alone or by several nerves.

2. Disturbances of sensation. There may be simple paresthesia or complete anesthesia. If the latter exists, the area will seldom correspond exactly to the normal cutaneous area supplied by the nerve. This is due to the fact that the anastomosis of the nerves of the skin is so free that, within a short period, the neighboring filaments often

assume the function of the sensory endings of the injured nerve. Complete anesthesia usually follows the injury of several nerves of an extremity.

In addition to the disturbances of tactile sense, there is often severe pain along the course of the nerve. This is most frequently the case in those nerves which are gradually compressed, as by a callus or by the end of a dislocated bone. The appearance of pain usually indicates an incomplete solution of continuity. It has been frequently shown that compression of mixed sensory and motor nerves first causes disturbances of the tactile sense and ability to recognize cold, while at a later period there is absence of heat sensation and the appearance of pain.

3. Vasomotor and trophic changes. The former causes redness and local rise in temperature, which are followed gradually by cyanosis and coldness of the limb. The trophic changes are usually most marked in the skin, rarely in the bones and joints unless the injury occurs early in life. The skin becomes smooth and shining, loses its elasticity, and deep ulcerations may occur. There is marked atrophy of the muscles and the joints become stiff and painful.

4. Changes in electrical reaction. In mild forms of contusion due to compression of the nerve there is seldom any change. Even though the paralysis be a complete one, after a contusion there may be no change in the electrical reaction.

If, however, the nerve is completely severed, the response of the nerve toward both faradic and galvanic stimulation begins to sink about the second day, and ceases completely by the end of the second week. The affected muscles also fail to respond to the faradic current, but show an increased irritability toward the galvanic. These changes may persist for some time after the muscles begin to respond to voluntary impulses.

5. The appearance of a tumor at the seat of injury. In some cases neuromata develop at the point where the nerve has been either contused or severed. A spindle-shaped enlargement can often be felt at the point where the nerve has been injured or cut, after a variable period, usually two to three months. In some cases, as in amputation stumps, it may be exquisitely tender to the touch.

Injuries of the nerves occur as the result either of pressure or of laceration of the nerve. The former may (*a*) immediately follow a single trauma, like a blow or a kick or the application of a constrictor; (*b*) it may follow the pressure of crutches (crutch paralysis); (*c*) the nerve may become compressed between the fragments of a fracture or by

a callus (Fig. 315). Lacerations of nerves follow (*a*) gunshot, stab, or any variety of wound made by cutting or tearing violence; (*b*) penetration by a fragment of bone in fractures; (*c*) crushing of the nerve without an external wound.

INJURIES OF THE INDIVIDUAL NERVES.

The **circumflex nerve** is most frequently injured in connection with fracture of the surgical neck of the humerus. It may also be injured in dislocations of the shoulder as well as in severe sprains, without fracture. The principal symptom is paralysis of the deltoid resulting in inability to raise the arm from the chest and in such marked atrophy that the normal convex outline of the shoulder is lost.

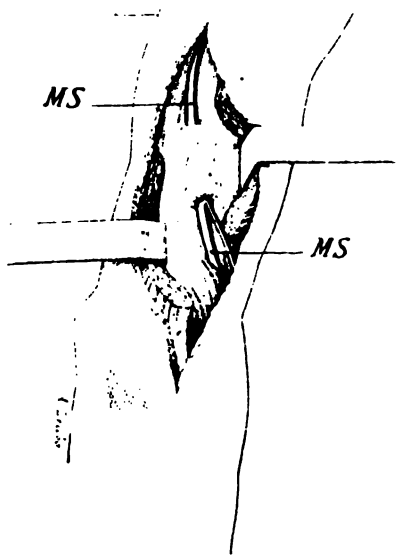


FIG. 315.—MUSCULOSPIRAL NERVE COMPRESSED BY A CALLUS RESULTING FROM A FRACTURE IN MIDDLE OF SHAFT OF HUMERUS (Lejars).

MS, Musculospiral nerve above and below point of compression by callus.

The **musculospiral nerve** is more often injured than any other in the body. In the axilla it may be compressed by the head in dislocations of the humerus or by the pressure of a crutch. At the middle of the shaft (Fig. 316) it may be compressed by too tight an application of a constrictor, or more often by being caught in a callus in fractures at this level. It may be torn by blows over this place without any wound of the skin. Its continuation, the radial nerve, is often severed in gunshot wounds of the forearm or in incised wounds just above the wrist.

The motor symptoms vary somewhat according to the level of the injury: (*a*) If in the axilla, the elbow, wrist, and fingers cannot be extended. (*b*) If at the middle of the humerus, the elbow can be extended but there is inability to supinate the forearm and to flex it, when

half-way between supination and pronation (supinator longus action). There is, in addition, the loss of movements of extension of the fingers and wrist. (*c*) If below the humerus, the elbow can be extended

FIG. 316.—WRIST-DROP

Due to pressure paralysis of the musculospiral nerve, following too tight an application of an Esmarch constrictor.

FIG. 317.—CLAW-HAND (MAIN EN GRIFFE) FOLLOWING ULNAR PARALYSIS (Leube).

and forearm supinated, but the inability to extend the wrist and fingers is more prominent (Fig. 316), causing the deformity known as wrist-drop.

The sensory symptoms are often so slight as to escape notice at

first, because the median and ulnar nerves establish a collateral supply. When anesthesia is present it is most marked over the back of the thumb and index-finger.

The **ulnar nerve** is injured either in gunshot or stab wounds of the forearm or in incised wounds just above the wrist. The motor symptoms are inability to flex the first and to extend the second and third phalanges of the fingers, resulting in a claw-like deformity (Fig. 317). The thumb cannot be adducted nor can the wrist be drawn toward the ulnar side. As a rule, there is anesthesia only over the little finger.

FIG. 318.—DUCHENNE PARALYSIS.

Due to tearing of the fifth and sixth cervical nerves during birth, close to their point of emergence from the spinal cord. (See text.) The position of the hand is typical.

The **median nerve** is most often injured in the same manner as the ulnar. The median nerve may also be injured in a supracondyloid fracture of the humerus by being pierced and fixed by the displaced upper fragment. The motor symptoms are inability to flex the fingers except the ring and little fingers. The first phalanges of the fingers cannot be flexed on account of paralysis of the interossei muscles. The thumb cannot be flexed or abducted. The area of anesthesia is usually very small and most marked over the volar surfaces of the thumb, index, and middle fingers.

The **brachial plexus** may be injured (*a*) through tearing of one of the nerve-roots close to its emergence from the spinal cord. These are known as birth paralyses. The most frequent type is that known as the Duchenne (Fig. 318). (*b*) In the axilla, as the result of dislocations or gunshot wounds. (*c*) In fractures and other injuries of the upper arm or forearm regions, several of the nerves of the plexus may be involved simultaneously. Of chief interest is the first named mode of injury, viz., traction on the arm during birth. It may result in a

subluxation of the humerus simulating a true dislocation. There is inability to raise the arm and to supinate the forearm, the latter being held pronated with a drop-wrist deformity.

The sciatic nerve and its branches are oftenest injured in the lower extremity. The main trunk may be severed by gunshot or stab wounds of the thigh. It is rarely caught by a callus or compressed by fragments at the time of injury, in supracondyloid fractures of the femur. Injuries of the main sciatic trunk are quite rare. They result in the absence of ability to use any of the muscles below the knee as well as inability to flex the knee-joint. There is anesthesia over a narrow strip from the gluteal fold to the calf of the leg, which then spreads so as to embrace all of the leg and foot except an area along the inner side supplied by the internal saphenous.

The **external popliteal** or **peroneal nerve** has been caught in a callus in fractures of the upper end of the fibula. Injury of this branch results in inability to raise the outer edge of the foot (paralysis of peronei), to extend the toes, or to flex the ankle. There is an area of anesthesia over the outer half of the front of the leg and dorsum of the foot.

GENERAL CONSIDERATIONS OF INJURIES OF THE BONES.

Injuries of the bones and joints of the extremities are so often associated that they will be considered together. Before taking up the diagnosis of injuries of the individual bones and joints, a short review of their more general characteristics will be of value.

These are, as a rule, of two varieties: (*a*) contusions; (*b*) fractures.

Contusions of the Bones.—These are the result of direct violence and affect the periosteum. For this reason the condition is often spoken of as a traumatic periostitis. The periosteum becomes greatly thickened and very tender. The diagnosis can readily be made by palpation in the more superficial bones like the tibia, where it most frequently occurs. At times the swelling in the periosteum becomes quite localized and fluctuates as the result of the liquefaction of a hematoma. In some places, like the neck of the femur, a contusion of the bone may be followed by softening and bending of the bone. (See Coxa Vara Traumatica.) The periosteum remains thickened for some time and then gradually resumes its normal size.

Infraction (Greenstick or True Incomplete Fracture).—In true infraction the conditions are similar to those observed when a green stick is bent, hence the name often given to it. The continuity of the bent bone is partially or completely interrupted. At the concave side of the bend

the cortex is folded into a ridge, while at the convex side there is a separation. This fracture is most frequently seen in the bones of the forearm, then in the clavicle, and very rarely in the bones of the arm, leg, or thigh. The great majority of cases occur under the age of fifteen years.

Depressions.—This variety of incomplete fracture usually occurs in the skull as a fracture of the outer table.

Separation of a Splinter or of an Apophysis.—In the first class, a chip of bone is broken off, while in the second class a bony prominence or apophysis is torn off.

Complete Fractures.—These are divided according to the line of fracture and the seat of the latter.

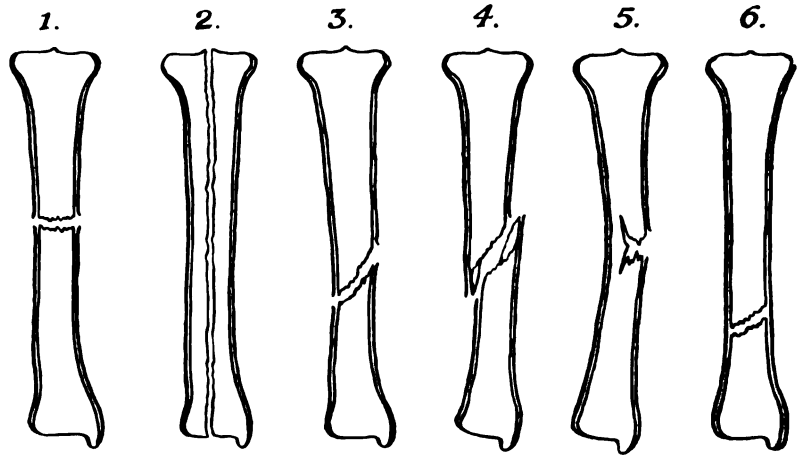


FIG. 319.—VARIOUS FORMS OF LINES OF FRACTURE.
1, Complete transverse; 2, longitudinal; 3, oblique; 4, spiral; 5, incomplete or greenstick; 6, subperiosteal.

(*a*) **Classification according to the Line of Fracture.**—*Transverse.*—The line of fracture does not deviate more than ten to fifteen degrees from that of the transverse axis. This variety is rare in the shaft of the long bones. It is usually found at the lower end of the radius or of the femur and in the short bones.

Longitudinal.—Only two cases have been reported of this variety of the line of fracture.

Oblique.—This and the next form are the most frequent, in the shafts of the long bones. In the oblique variety the direction of the line of fracture may form any angle with the transverse axis of the bone up to a right angle. When it approaches the latter, it belongs to the group of longitudinal fractures. In the oblique variety the line of fracture may be single or multiple.

Spiral.—This variety of the direction of the line of fracture was formerly considered to be very rare. The more systematic use of the *x*-ray as part of the routine of diagnosis has shown that spiral fractures are quite frequent in the shafts of the humerus, femur, tibia, and fibula. They will be referred to in detail under the appropriate heads. They are usually the result of a rotating or twisting force. The ends of the fragments in the transverse, oblique, and spiral varieties are usually more or less irregular. In some instances the toothed or dentate condition of the line of fracture may prove to be a serious obstacle to reduction.

Comminuted Fractures.—In this variety there is extensive splintering of the bone adjoining the fracture or of one of the fragments.

Impacted Fractures.—This variety usually occurs in the neck of the femur, at the surgical neck of the humerus, and at the lower end of the radius. In the latter two instances the end of the shaft is forced through the soft expanded end of the bone. In the case of the neck of the femur the neck is either forced into the head or one portion of the neck into the adjacent part.

Compression or Crushing Fractures.—This variety usually occurs in the tarsal bones. The spongy portion and cortical layer are both crushed. In some cases there is a perfect pulpification of these bones. This variety occurs after falls from a height upon the sole of the foot.

Subperiosteal Fractures.—Complete tearing of the periosteum all around the bone, along the line of fracture, is infrequent, and is found only in fractures accompanied by great displacement of fragments. A special variety of fracture has been described recently in which the periosteum is not torn, and the term subperiosteal fracture has been given to this variety. The diagnosis of these can only be made through the use of the *x*-ray.

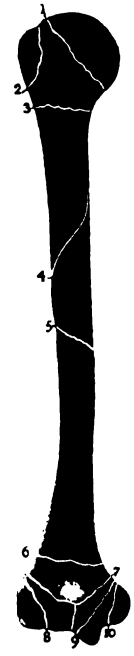


FIG. 320.—LOCATIONS OF MOST FREQUENT FRACTURES OF THE HUMERUS.

1, Of the anatomic neck; 2, of the greater tuberosity; 3, of the surgical neck; 4, spiral fracture of shaft; 5, oblique of shaft; 6, supracondyloid; 7, T or Y-shaped, at lower end, extending into joint; 8, of external condyle; 9, of internal condyle; 10, of internal epicondyle.

(*b*) **Classification according to their Location in the Bone.**—Fractures are often referred to according to their relation to the shaft or some special point in a bone.

Those occurring in the diaphysis of a bone are spoken of as fractures

of the shaft. Fractures occurring at the ends of bones receive the name of the part which the line of fracture traverses; for example, fractures of the neck of a bone, of a tuberosity, of a process, of a condyle, etc. There are two forms of fracture which require special mention in connection with their location. These are epiphyseal separations and joint fractures.

Epiphyseal Separations.—The union of the epiphyses to the diaphyses commences during the period of puberty, hence these fractures are less common in childhood than after the ages of eleven or twelve. As a rule, they can only occur before the twentieth to twenty-first year.

Articular Fractures (Joint Fractures).—These fractures, like epiphyseal separations, deserve special mention, since their recognition and

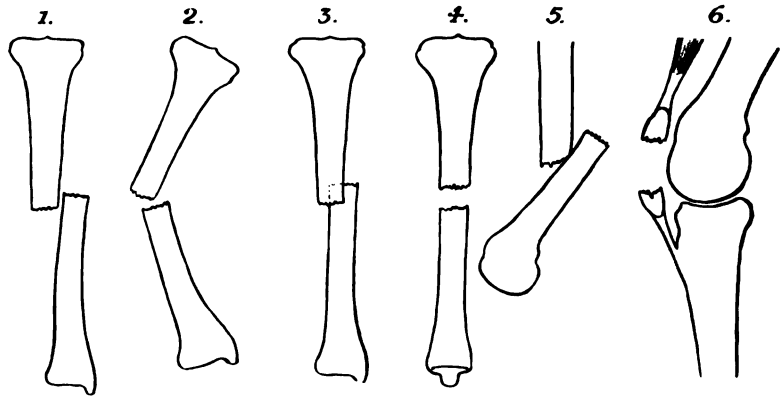


FIG. 321.—VARIOUS FORMS OF DISPLACEMENT OF FRAGMENTS IN FRACTURES.
1, Lateral; 2, angular; 3, overriding; 4, axio-rotation; 5, overlapping and angular combined; 6, great separation of fragments.

proper treatment have assumed such great importance. Articular fractures may be divided into three classes:

1. *Intra-articular:* In these the line of fracture lies entirely within the joint. Such joint fractures are most frequently found in the elbow- and knee-joint. In both of these localities they undoubtedly play an important rôle in the formation of free joint bodies.

2. *Para-articular:* In these the line of fracture extends close to the joint, but not into it. An example of this class is the supracondyloid fracture of the humerus.

3. *Articular fractures proper:* The majority of joint fractures belong to this class. The line of fracture either extends into the joint from without, or it extends from the joint outward.

Classification according to Etiology.—Fractures may be divided

according to their causes into two groups—the traumatic and the spontaneous or pathologic. In the former, the fracture is the result of violence acting upon a bone which is either normal or shows slight changes due to the physiologic causes to be referred to.

A spontaneous or pathologic fracture is one which occurs in a bone the strength of which has been diminished by some preceding abnormal changes. In this variety, the degree of force which produced the fracture would not be sufficient to cause a fracture in a healthy bone.

Pathologic or Spontaneous Fractures.—The more correct term for those fractures, which occur either after slight or practically no trauma in bones which are not normal in structure, is *pathologic fracture.* One of the best classifications is that given by Grunert.[1]

I. *Fractures Associated with Local Lesions of Bone.*

A. Tumors.

1. Primary and metastatic sarcoma.
2. Metastatic carcinoma and hypernephroma.
3. Metastatic thyroid tumors.
4. Solid enchondroma and benign bone cysts.
5. Echinococcus cysts.

B. Inflammatory processes.

1. Infectious osteomyelitis (pyogenic).
2. Tuberculosis of bone.
3. Syphilis.
4. Aneurysms.
5. Bone cysts (osteitis fibrosa of Recklinghausen) (see Fig. 682).

II. *Fractures Associated with General Diseases.*

A. Neuropathies.

1. Tabes dorsalis.
2. Syringomyelia.
3. Mental diseases.

B. Senile changes.

C. Exhausting chronic diseases.

D. Atrophy due to non-use.

E. Scurvy.

F. Rickets and Osteomalacia.

III. *Idiopathic Friability of Bone* (osteoporosis, fragilitas ossium).

It is of importance to note that in many cases, especially in those of primary sarcoma, tabes, syringomyelia, etc., the fracture may be the first symptom. In general, it is well to remember that a *fracture occur-*

[1] "Deutsche Zeitschrift für Chirurgie," Bd. lxxvi.

ring after the use of a minimum amount of force should be investigated as to the possibility of its being of a pathologic variety. Union may rarely occur in the ordinary manner after these fractures.

The Healing of Fractures.—Union by callus formation occurs a little more rapidly in children than in adults. The average length of time required for firm union is as follows: (*a*) For the ribs—three weeks; (*b*) for the forearm, humerus, clavicle, bones of leg—four to five weeks; (*c*) for the femur—six to eight weeks.

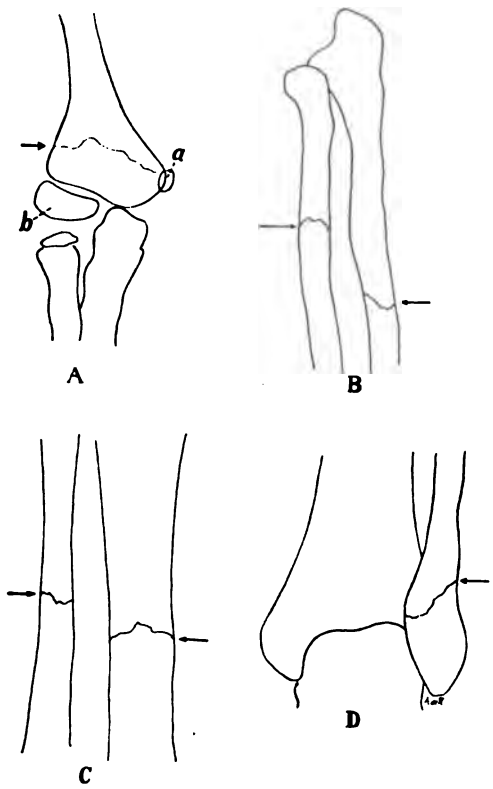


FIG. 322.—SUBPERIOSTEAL FRACTURES (Lauenstein).

A, Of the lower end of the humerus; *a*, internal condyle epiphysis; *b*, external condyle epiphysis. The arrow in all of the figures points to the seat of the fracture. B, Subperiosteal fractures of the ulna and radius; C, of the tibia and fibula at middle of shaft; D, of the external malleolus.

Simple fractures and compound fractures without infection, heal more rapidly than do any other forms. Union in infected compound fractures is often greatly delayed, as is also the case with fractures involving the larger joints (intra-articular).

In children and in some adults the amount of callus formation is excessive. In superficial bones like the clavicle such an exuberant callus may simulate a displacement of fragment. The callus even in such gradually decreases in size after a short period.

Complications of Fractures.—The following are the chief complications which occur during the clinical course of a fracture:

1. *Formation of bullæ in the skin*, especially in fractures of the leg.

2. *Thrombosis and Embolism.*—Not infrequently, a thrombosis of the deep veins of the lower extremity occurs in fractures of the bones of the leg, as well as in those of the patella and femur. A marked swelling of the entire limb occurs, which is far greater than that ordinarily accompanying such a fracture. It is often observed for the first

time when a cast or other retentive apparatus has been removed and the patient allowed to get about. Quite rarely an embolus is detached and causes marked dyspnea, rapid pulse, and often results in death.

3. *Fat Embolism.*—Small amounts of fat are washed off into the circulation with every fracture. Quite rarely the fat emboli lodge in the brain, lungs, and kidneys, and give rise to serious symptoms, and, in some cases, death occurs.

In the lungs, the fat infarcts are followed by edema and patches of pneumonia. The symptoms of fat embolism are usually mistaken for those of shock, but begin a little later. In some cases pulmonary symptoms, such as rapid breathing, dyspnea, and coarse râles predominate. In other cases cerebral symptoms, such as coma, twitchings, slow stertorous breathing, etc., are more marked.

FIG. 323.—X-RAY OF PSEUDARTHROSIS OF ULNA FOLLOWING CRUSHING INJURY OF THE ENTIRE UPPER EXTREMITY.

Taken two years after the injury. Notice the well-marked lower epiphyses of the radius and ulna, and the silver wire *in situ* in the middle of the shaft of the humerus.

4. *Injury to Blood-vessels.*—These have been described on page 492.

5. *Injury to Nerves.*—These may occur either at the time of the injury, as a result of compression or laceration of the nerve, or at a later period, through inclusion of the nerve in a callus. The recognition of these has been described on page 496.

6. *Septic Complications.*—These are more likely to occur in connection with compound fractures or as a complication of the gangrene following injury of the vessels of the limb.

The various forms of infection are the same as those which complicate other injuries of the extremities, and are described on page 607.

7. *Osteomyelitis.*—This only occurs in infected compound fractures and will be described later (page 662).

8. *Delirium Tremens and Traumatic Delirium.*—Hallucinations of vision, muscular twitchings, restlessness, and a muttering delirium accompanied by rapid heart's action, are frequent and often fatal complications of fractures in alcoholics. The same group of symptoms may occur in individuals not addicted to drink, and the condition is then called

FIG. 324.—X-RAY OF PSEUDARTHROSIS OF MIDDLE OF SHAFT OF HUMERUS (G. G. Cottam).

simple or traumatic delirium. The latter is more apt to occur in elderly persons after injuries.

9. *Pulmonary Edema and Pneumonia.*—Pneumonia appears either as an early complication in a lobar form, or late as a hypostatic pneumonia. Both are more apt to occur in elderly people, and especially in alcoholics. The lobar or early type runs a rapid and severe course with

high fever and delirium. In the late or hypostatic form, the symptoms appear gradually a few weeks after the injury, with a lower range of temperature, stupor, and rapid pulse.

10. *Defective Callus Formation* (*Pseudarthrosis*).—The terms delayed union, fibrous union, failure of union, and pseudarthrosis are often employed in an erroneous manner. We speak of delayed union when it does not occur within the usual period, but in eight to twelve weeks, and in some instances even later. By fibrous union is meant that the fragments are held together by fibrous tissue. This occurs normally in the healing of the majority of fractures of the patella and olecranon, and can only be considered as pathologic when it takes place in bones in which

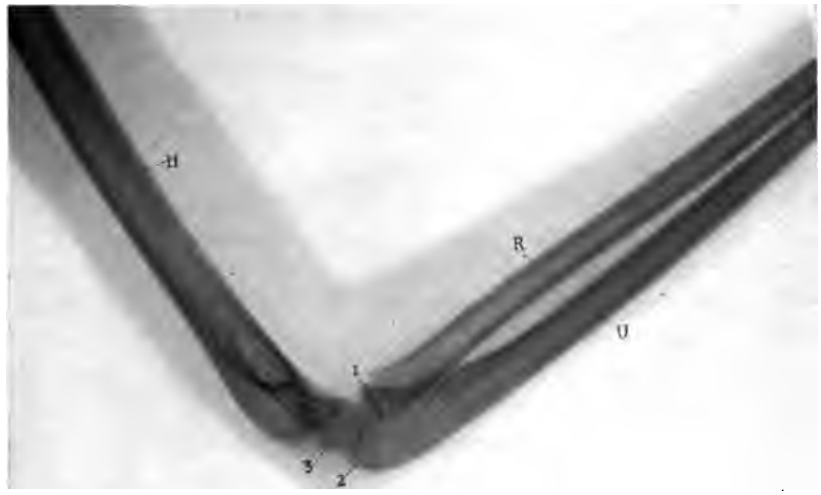


FIG. 325.—VIEW OF NORMAL ELBOW-JOINT OF A BOY TEN YEARS OF AGE.
R, Shaft of radius; U, shaft of ulna; H, shaft of humerus; 1, upper epiphysis of radius (capitellum); 2, epiphysis which forms the tip of the olecranon process; 3, lower epiphysis of humerus.

bony union is the rule. While delay of union is frequent, *a true failure of union* is rare. It occurs only when some definite bone disease exists or no attempt has been made to fix the bone. The term pseudarthrosis should be applied to those cases in which a distinct false joint is formed at the seat of fracture, as in Fig. 324.

This can be recognized by persistence of mobility at the point of fracture and the fact that an *x*-ray fails to show a shadow, indicating ossification of the callus. A false joint is formed at the point of fracture. The fragments are bound together by fibrous bands. A cavity is formed in which the rounded ends of the bones rub on each other (Fig. 324). There is no attempt at union at all, the ends of the bone becoming atrophied.

It is of importance to recognize the causes of non-union or delayed union. These may be divided into local and general.

(1) *Local.*—(*a*) Imperfect immobilization of fragments. This is one of the most frequent causes.

(*b*) Great separation of fragments either through failure to reduce them properly or as the result of muscular action.

(*c*) Interposition of bone, muscle, or tendon between the fragments.

(*d*) Poor blood-supply.

(*e*) Tumors developing in a callus or where a fracture has occurred as the result of one of the pathologic causes mentioned on page 505.

(2) *General.*—(*a*) Neuropathic causes, *e. g.*, tabes, syringomyelia, paralysis.

FIG. 320.—METHOD OF MEASURING THE CIRCUMFERENCE OF THE KNEE-JOINT.
In order to determine any increase in size, due to the presence of fluids, tumors, etc. (See text.) The method of measurement is the same as was described under Fig. 304.

(*b*) Constitutional causes, *e. g.*, acute infectious diseases, rickets, scurvy, gout, rheumatism, chronic nephritis, diabetes, alcoholism.

The Diagnosis of Fractures in General.—The diagnosis of a fracture of one of the bones of the extremities does not differ from that of the bones previously considered in the chapters on the head and thorax.

The following routine should be followed in the examination of a case:

1. History of patient's condition of health before the accident and also how the accident occurred.

2. Objective signs, such as deformity, abnormal mobility, crepitus and ecchymoses.

3. Subjective symptoms, such as pain and loss of function of the limb.

4. Examination with the *x*-ray.

1. *History.*—This should include the history of any previous accidents which may have caused shortening or other deformity of the limb. An exact account of how the accident occurred, will enable one to judge of the degree of force employed and also whether the mode of injury was such as to produce a fracture by direct or indirect violence. The patient in some cases may call attention to a snapping sound when the bone broke, followed by an immediate loss of function. The previous history is of especial importance where the trauma has been slight because of the possibility of the fracture being a pathologic one (see page 505).

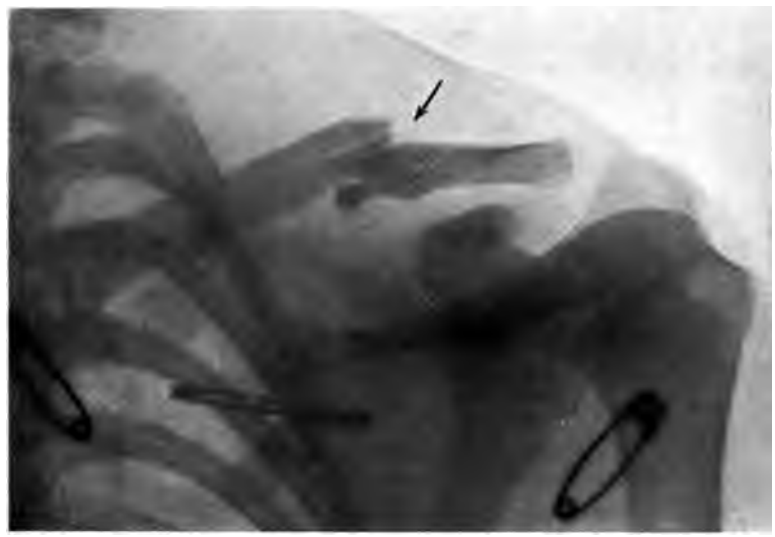


FIG. 327.—X-RAY OF FRACTURE OF CLAVICLE IN A BOY OF EIGHTEEN.

The black arrow points to the seat of fracture. The inner fragment has been pulled upward and the outer fragment is displaced behind the inner one. The clear space between the outer end of the clavicle and the acromion process is due to the lack of ossification of the outer epiphysis of the former.

2. *Objective Signs.*—All of these may be present in a case or one or more be absent. (*a*) *Deformity* is determined by inspection, measurement, and palpation of the injured part. It must not be forgotten that there is often a quite perceptible ($\frac{1}{4}$ to $1\frac{1}{2}$ inches) difference in length between opposite limbs of a normal adult (especially in the lower). (*b*) *Abnormal mobility of the bone* at a point where it is not normally present is one of the valuable signs of fracture. It is absent in the impacted and incomplete varieties as well as in the intraarticular form. The methods of determining this sign are discussed in the section on special fractures. (*c*) *Crepitus.* This sign, like that of abnormal mobility, is pathognomonic. It is a grating sensation due to the rubbing of the broken ends upon each other. It resembles abnormal mobility in being absent in im-

pacted, incomplete, and articular fractures. It is also absent when a considerable separation or displacement of the fragments is present or when some foreign substance is interposed, like muscle, bone, etc., between the broken ends. (*d*) Ecchymosis, when it appears over a considerable area in a limb which has not been subjected to direct violence, is of great value as a sign.

3. *Subjective Signs of Fracture.*—(*a*) *Pain.*—This is a constant accompaniment of a fracture. It is but little marked when there is con-

FIG. 328.—METHOD OF EXAMINATION FOR FRACTURE OF THE CLAVICLE.

The patient's left arm in the case of suspected fracture of the left clavicle is allowed to rest upon the left forearm of the examiner, so that the patient's arm as a whole can be raised or lowered as desired to determine a false point of motion, which the examining finger or fingers of the opposite or right hand of the surgeon can readily feel.

siderable diastasis of fragments and if the fracture is impacted. It is of value if it is quite localized, in fractures sustained by indirect violence, especially if it is most marked on movement of the bone or pressing the ends together. The pain of a fracture lasts, as a rule, much longer than that of contusions or sprains. In fractures due to direct violence the injuries of the soft parts often disguise the bone pain.

(*b*) *Loss of Function of the Limb.*—In many cases this is a valuable

sign when taken in conjunction with the objective ones. In the majority of individuals there will be inability to use the limb. Exceptionally, however, one will find persons walking about on a fractured leg or using a broken arm.

4. *X-ray Examination.*—This method has become one of the most valuable aids in the diagnosis of injuries of both bones and joints. It serves the double purpose of confirming the diagnosis of fracture and of giving much information as to its exact nature. The *x*-ray should not be employed, however, to the exclusion of the other objective methods. It has the great advantage, especially in the case of fractures in deep-seated bones and in those close to joints, of enabling a diagnosis to be made at an earlier hour and with less manipulation than any of the other methods. The most accurate pictures can be obtained by the use of a special dia-

FIG. 320.—DISLOCATION UPWARD OF THE ACROMIAL END OF THE CLAVICLE.
The arrow points to the depression lying between the bony prominence, caused by the separation of the acromia end of the clavicle from the acromion process of the scapula.

phragm apparatus (page 425) such as is employed in taking skiagraphs of calculi in the kidney (see page 425). This method is to be especially recommended for skiagraphy of joints such as the hip or shoulder, for the phalanges of the toes or fractures of the pelvis.

Every one should perfect himself in the examination of normal limbs by the ordinary methods of inspection, palpation, and mensuration. The examination of a fractured limb for deformity, abnormal mobility, and crepitus will soon become a routine procedure, and the *x*-ray will occupy its true position of confirming and amplifying a diagnosis previously made by the other methods. It is essential to have a knowledge not only of the bony landmarks, etc., of the normal limbs, but of the skiagraphic appearance of the various bones and joints at all ages.

The normal epiphyseal cartilage looks to the novice like a fracture

line (Fig. 325), so that one of the most valuable contributions to skiagraphy during recent years has been the study of the joints from infancy to the time ossification has been completed.

It must be remembered that the amount of deformity as shown by the *x*-ray is often exaggerated and appears far greater than seems to be the case by external examination.

For information in regard to the necessary time of exposure, the angle at which the picture should be taken, and other technical points one should consult the special treatises on this subject.

Examination of the patient's general condition for evidences of shock, loss of blood, or visceral injury should never be omitted. These have been referred to under the head of complications (see page 506), and will be spoken of in connection with certain fractures.

Special points in the diagnosis of fractures to be mentioned are the following:

(*a*) The rough eroded surface of a dislocated joint after reduction will simulate bony crepitus.

(*b*) Apparent abnormal mobility in such bones as the ribs and in the long bones of children is often the result of the normal elasticity of the bones.

(*c*) In parallel bones, such as those of the ribs, forearm, metacarpals, leg, and in the metatarsals, the ordinary signs of fracture, viz., crepitus, abnormal mobility, and deformity, are often indistinct and difficult to elicit. The same is true of the carpal and tarsal bones, as also of fractures where the fragments are dentated.

(*d*) An incomplete fracture is often overlooked until the presence of callus shows that injury to a bone has occurred.

(*e*) In impacted fractures deformity is often the only evidence of a fracture.

(*f*) Compound fractures should be manipulated as little as possible unless operative interference is indicated.

(*g*) An incision to convert a simple into a compound fracture for diagnostic purposes is not good practice unless it has for its object the correction of the position of fragments, the relief of pressure on vessels or nerves, or a search for visceral injury.

Value of Objective Signs (Excluding *x*-Ray) in the Diagnosis of a Fracture.—If all the classic signs of fracture are present, the diagnosis is positive. All these signs may, however, be absent in incomplete or in subperiosteal fractures, in some of the articular fractures, and in epiphyseal separations without displacement.

Deformity is absent in transverse fractures and in those into joints.

Abnormal mobility is absent in impacted fractures, or when one of two parallel bones are broken or if the fragments are dentated, and also in subperiosteal fractures. Crepitus is absent if there is an interposition of soft parts or if the fragments are widely separated (olecranon, patella, os calcis).

In some cases only two of the classic signs can be found, and in others only one.

Value of Subjective Signs.—Pain, if persistently located at the same point, is of value, especially in fractures by indirect violence. Disturbance of function is also a valuable sign if continued over a long period, and is not due to simulation.

The Diagnosis of Articular Fractures.—The diagnosis of all three varieties of articular fractures does not differ from that of other fractures of the long bones. The most characteristic symptom is the presence of an intraarticular effusion, usually bloody in character. This, taken in conjunction with the ordinary signs of fracture and an *x*-ray examination, will usually enable a diagnosis to be made. In cases in which the joint fracture is complicated by a dislocation the diagnosis is very difficult without an *x*-ray.

Special Features of Traumatic Epiphyseal Separations.—The long bones have a large epiphysis at each end of the shaft or diaphysis. The clavicle, metacarpal, and metatarsal bones and the phalanges of the hand and foot are an exception, having only one epiphysis. At birth the epiphyses are almost entirely cartilaginous, with the exception of the lower epiphysis of the femur and the upper epiphysis of the tibia. In the case of the long bones, the whole diaphyses are ossified at birth. They increase in length by the addition of bone at the junction of the diaphysis or shaft and the epiphyseal cartilage.

Frequency of the Various Separations.—Poland has collected over 700 cases of epiphyseal separation. The order of frequency of these is as follows:

1. Upper epiphysis of the humerus.
2. Lower epiphysis of the femur.
3. Lower epiphysis of the radius.
4. Lower epiphysis of the humerus.
5. Lower epiphysis of the tibia.
6. Upper epiphysis of the tibia.

Epiphyseal separations, like fractures, may be incomplete or complete. In the majority of cases the cartilage drags with it more or less of the osseous tissue of the diaphysis. The incomplete separations are also called juxta-epiphyseal sprains, and are often overlooked.

Symptoms and Diagnosis of Epiphyseal Separations; Separation with Displacement; History of the Injury.—This is of great importance, often suggesting the possibility of an epiphyseal separation.

Age.—The period during which they are most likely to occur is between twelve and twenty.

Mobility.—This is the only symptom upon which reliance can be placed. Such abnormal mobility at the level of the epiphyseal cartilage is a most certain sign. In some cases it will be less distinct on account of the impaction of fragments, or from the fact that there is a more or less extensive fracture of the diaphysis.

Deformity.—This will vary according to the displacement of the diaphysis. In many the tendency to displacement is slight. When marked, the osseous projection of the diaphysis appears as a distinct ridge to be felt beneath the skin. It feels more or less smooth, regular, and uniform, unlike the rough and irregular projection of true fractures. In the case of the upper end of the humerus a cup-like hollow has been felt on the inferior aspect of the epiphysis. In separation of an epiphyseal process the exact form of the normal epiphysis may be recognized in the detached fragment.

Crepitus.—There is no true bony crepitus. It is an indistinct, dull, soft grating of a muffled character. This is especially the case in younger infants, while in older children the crepitus will be more like that of a true fracture, especially if there is an accompanying fracture of the diaphysis.

Pain at the diaphysis-epiphyseal line is of great value when present.

Swelling of the Joint.—This is usually very marked, causing considerable enlargement and giving rise to great pain.

Ecchymoses and Swelling of the Soft Parts.—These are very extensive and obscure the outlines of the bones.

x-Ray.—This, as in true fractures, is of the greatest aid, but a correct interpretation requires familiarity with the conditions in children at different ages. It is also advisable to take pictures in several directions and compare them with those of the uninjured side.

Separation without Displacement (Epiphyseal Sprains).—The symptoms of this condition are so few and uncertain that they are either overlooked or regarded as sprains.

The signs are: (*a*) pain and tenderness on pressure about and along the epiphyseal line; (*b*) contusion or ecchymosis about the joint; (*c*) loss of power of the limb; (*d*) mobility often slight; (*e*) rigidity of the limb on account of the pain caused by movement.

Epiphyseal separations differ from fractures in many particulars:

(*a*) The shape of the displaced epiphyseal fragments is often quite unmistakable. (*b*) The deformity is very characteristic, especially at the upper end of the humerus. (*c*) Crepitus is soft and smooth unless the diaphysis has also been broken.

From a dislocation, an epiphyseal separation can be distinguished by the facts that: (*a*) Dislocations are very rare in infancy and early childhood. (*b*) Moderate traction will restore the displaced fragments to

FIG. 330.—METHOD OF EXAMINATION TO BE EMPLOYED IN MAKING A DIFFERENTIAL DIAGNOSIS BETWEEN DISLOCATION OF THE SHOULDER-JOINT AND FRACTURE OF THE ANATOMICAL OR SURGICAL NECK OF THE HUMERUS.

This illustration shows the manner of examining the head of the humerus in order to determine whether it has its normal range of rotation, thus aiding in ascertaining whether the head of the humerus lies in the glenoid cavity. The method consists in grasping the forearm of the patient close to the wrist, with one hand, while the head of the humerus is held between the thumb in front and the remaining fingers behind, *i. e.*, along the anterior and posterior borders respectively of the deltoid muscle.

their natural position in an epiphyseal separation, but when the traction is discontinued, it will recur. In a dislocation there will be but little tendency for the displacement to recur. (*c*) The deformity is often quite similar to that of dislocation, but palpation of the projecting diaphysis will show it to differ from that of the articular end. (*d*) Abnormal mobility is also quite characteristic of an epiphyseal separation. (*e*) By

measurements between the bony points of the two or more bones composing the joint. In dislocation the measurements will be altered; in epiphyseal separation, as a rule, they will be unaltered.

If the swelling is too great to permit of manipulation and palpation, an anesthetic should be given. A more careful examination can then be made. A skiagraph will often avoid even the use of an anesthetic.

FIG. 331.—METHOD OF DETERMINING THE DISTANCE BETWEEN THE ACROMION PROCESS (*A–P*) AND THE EXTERNAL CONDYLE OF THE HUMERUS (*E–C*), BY MEANS OF A STEEL TAPE-MEASURE.

This method is often used in order to compare the humerus of one side to that of the other, and also for the purpose of determining the distance between these two points in the diagnosis of dislocations of the head of the humerus or fractures of the surgical neck.

Compound epiphyseal separations must be differentiated from compound dislocations or compound fractures close to or into joints. This can be readily done by a skiagraph combined with examination of the wound after the employment of every possible means to avoid septic infection.

GENERAL CONSIDERATIONS UPON INJURIES OF THE JOINTS.

An injury to a joint, whether the force be applied in a direct or an indirect manner, will result in one of the following conditions: (*a*) A traumatic arthritis; (*b*) a penetrating wound of the joint; (*c*) a dislocation.

Traumatic Arthritis.—The term sprain was formerly applied to all forms of non-penetrating joint injury, except dislocations. With advancing knowledge of both the pathologic and clinical aspects of these

FIG. 332.—X-RAY OF FRACTURE OF SURGICAL NECK OF HUMERUS IN A BOY TEN YEARS OF AGE.

The arrow points to the line of fracture. The lower fragment, FD, has been pulled upward and outward through the action of the deltoid muscle, so that it forms, as is frequently the case, an angle with the upper end of the bone; FE, upper epiphysis of humerus on injured side. The clear line just below it, and separating it from the shaft or diaphysis, is due to the fact that the epiphyseal cartilage does not cast a shadow. NE, Epiphysis on normal side; ND, diaphysis or shaft on normal side.

injuries it seems proper to speak of a traumatic arthritis. This term includes injuries to all of the structures of a joint, viz., synovial membrane, capsule, intraarticular and extraarticular ligaments, cartilages, etc. In joints the immediate or remote consequences of injury may be:

(*a*) A serous or hemorrhagic effusion.

(*b*) Stretching or rupture of the capsule.

(*c*) Stretching or rupture of one or more ligaments.

(*d*) Complete or incomplete dislocation or tear of the intraarticular cartilages.

(*e*) Formation of free joint bodies.

(*f*) Recurrent effusion into a joint, often called intermittent hydrops.

The diagnosis of these various conditions can be made either (*a*) shortly after the injury or (*b*) at a later period.

(*a*) *Diagnosis Shortly after Injury.*—In the majority of joints, a traumatic arthritis can be recognized by the diffuse pain and swelling which sets in soon after the injury. The presence of an effusion can be recognized in the more superficial joints, by the obliteration of the normal depressions, by fluctuation, obtained as elsewhere, by bimanual manip-

FIG. 333.

Frequent mode of displacements of fractures of the surgical neck or of the humerus, or of separation of the upper epiphysis in children. *L*, Lower fragment (shaft), displaced inward and forward. Compare with Fig. 334.

FIG. 334.

Side view of a case of a fracture of the surgical neck of the humerus showing lower fragment displaced upward and forward in boy of ten. Compare with Fig. 333.

ulation, and in the knee, by the ballottement of the patella (Fig. 521). The measurement of the circumference of the joint (Fig. 326) should be compared with that of the opposite side. For both diagnostic and therapeutic purposes it is often advisable to aspirate the fluid under all possible aseptic precautions.

In deeper joints, like the hip and shoulder, the presence of an effusion is difficult to detect. In such cases one can judge by the position in which the limb is held; in the shoulder this is adduction; in the hip, flexion, slight abduction, and outward rotation.

In the majority of cases, in addition to the effusion, there is severe pain which may be localized at first at the point of insertion of a ligament. Pathologically such cases are accompanied by stretching of ligaments and of the capsule. These are the cases ordinarily spoken of as *sprains*. The more hemorrhagic the character of the exudate, the greater the probability of tears of the capsule or ligaments, or of a fracture extending into the joint.

FIG. 335.—X-RAY OF IMPACTED FRACTURE OF SURGICAL NECK OF THE HUMERUS IN A MAN OF THIRTY-FIVE. The outlines of the line of fracture were traced in ink upon the *x*-ray. The shaft of the bone has become impacted into the head.

In large joints like the knee a diagnosis of a tear of one of the lateral ligaments may be made at an early period by obtaining abnormal lateral mobility (Fig. 335).

At a later period, when the effusion has disappeared, one must bear in mind the possibility of the other sequelæ of a traumatic arthritis. These sequelæ of a traumatic arthritis are:

(*a*) *Rupture of Ligaments.*—There is either abnormal mobility or

one can palpate a distinct gap, as in the case of a torn ligamentum patellæ. In slight tears there is often persistent pain referred to the point of insertion.

(*b*) *Subluxation of Cartilages.*—This only occurs in the knee-joint as a result of forced rotation, involving the internal meniscus or semilunar cartilage, far more often than the outer. Complete dislocation has never been observed. The diagnosis is seldom made at the time of the injury, because there is such a marked effusion that palpation is impossible, and the case is treated as a sprain. At a later period there is a history of sudden attacks of pain in the knee and inability to move it, the joint being often fixed in a position of slight flexion. The patient may fall to the ground on account of the severe pain in the knee, but usually he is able to remain erect, but cannot support himself on this knee. The patient often experiences a sensation as though something moved in the joint or snapped back with a distinct click. Some patients observe a prominence on the inner or outer sides of the joints.

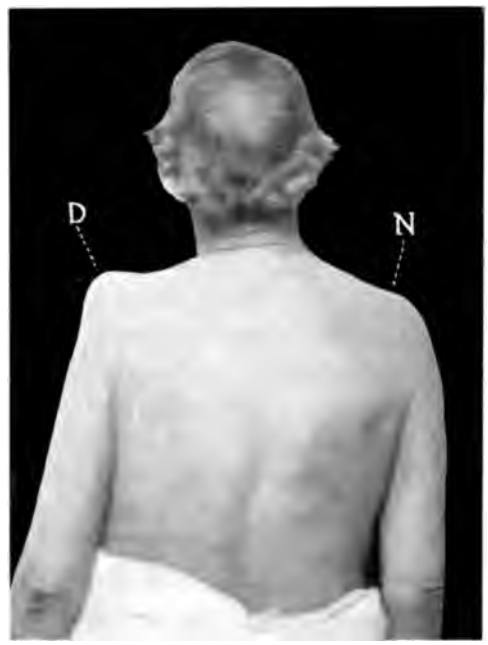


FIG. 336.—POSTERIOR VIEW OF SUBCORACOID DISLOCATION OF SHOULDER-JOINT.

Same case as shown in Fig. 337. N, Normal shoulder; D, dislocated shoulder.

If the attacks recur frequently they are milder than if far apart. In the latter there is usually more or less effusion present.

The patients can often reduce the luxation by traction on the leg and by rotation.

Vollbrecht[1] has described two groups of cases. In the first the original injury is followed, after a long confinement to bed, by the typical attacks, which are almost continuous.

In the second group there is an apparent recovery from the first ac-

[1] Bruns: "Beiträge zur klinischen Chirurgie," Bd. xxi.

cident after a tedious convalescence. After a second or third trauma the typical clinical picture sets in. One of the most characteristic objective signs is the interference with movements. Both flexion and extension are actively and passively interfered with. Another confirmatory sign, if found, is the palpation of a movable body in the gap between the femur and tibia. There is also great tenderness over the dislocated meniscus.

(*c*) *Free Bodies in the Joints.*—These have been variously termed floating cartilage, loose cartilage, joint mice, etc. They may result from the application of a direct (fall, blow, crush) or of indirect force (sudden tension of muscles or ligaments, torsion). They may occur even after very slight injury. They occur oftenest in the knee-joint, but may also follow injury to the shoulder, elbow, and wrist.

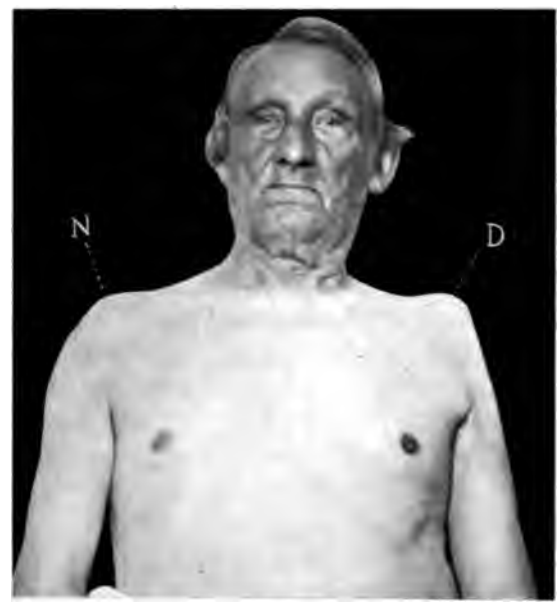


FIG. 337.—ANTERIOR VIEW OF DISLOCATION OF SHOULDER-JOINT.

Same case as shown in Fig. 336. N, Normal shoulder. Note the absence of prominence of the acromion process, and the presence of the normal convexity of the shoulder. D, Dislocated shoulder. Note the prominence of the acromion process, and the flattening of the shoulder, due to absence of the head of the humerus.

The most characteristic symptom is the so-called "locking" of the joint, due to the fact that the foreign body becomes wedged between the articular surfaces. There is severe pain and the joint is suddenly checked in its range of motion, so that flexion and extension cannot be executed. Such attacks may be accompanied by considerable effusion. Occasionally the free body can be felt and held between the fingers. After some manipulation the floating cartilage becomes free and the joint can be used again.

The typical symptoms may not appear until some time (months to years) after the injury or they may become noticeable immediately after the initial symptoms have passed away.

GENERAL CONSIDERATIONS UPON DISLOCATIONS.

Dislocations are either (*a*) traumatic, (*b*) pathologic, or (*c*) congenital in origin. They may, as in the case of fractures, be either simple or compound, according to whether or not there is a communication between a wound in the skin and the seat of injury.

If a dislocation tends to recur from time to time after having been reduced, it is termed a *recurrent or habitual dislocation.* These are most frequently found in the hip- and shoulder-joints, and a knowledge of their causes is important from a diagnostic point of view. In the case of the shoulder the most frequent causes are a breaking off of the rim of the glenoid cavity or a fracture of the greater tuberosity. In the hip, a fracture of the rim of the acetabulum allows the head to constantly slip out again.

If a dislocation has remained unreduced for a long period it is called an *inveterate or ancient or unreduced dislocation.*

The *pathologic or spontaneous dislocations* are the result either of (*a*) an excessive distention of the capsule, (*b*) a malformation as the result of disease of the articular ends of the bones composing the joints. In both cases, following a slight trauma or independent of one, the dislocation occurs. These spontaneous or pathologic dislocations are described in the section on diseases of the joints. The diagnosis of these pathologic dislocations can be made by a consideration of the history, combined with examination of the joint and the skiagraph. The actual dislocation is often preceded by pain and swelling of the joint. In the case of dislocation by distention, the history will reveal a previous acute infectious disease, such as typhoid, scarlatina, pneumonia, rheumatism, or pyemia. In a dislocation due to destruction of the end of the bone the history and examination will show a tuberculous or pyogenic osteomyelitis or a primary neoplasm in some other part of the body. In neuropathic dislocation one must search for signs of tabes or syringomyelia.

A dislocation may be complicated by injury of the soft parts or by a fracture involving the articular bone ends. Compound dislocations are much more apt to be complicated by injuries of vessels and nerves than the simple are.

The recognition of an *injury to one of the blood-vessels of the limb* is difficult. Such a lesion, as a rule, occurs oftenest in the reduction of dislocations of the shoulder. The signs are:

The pulsations of the artery below the point of impingement cannot be felt, the limb is cold, and pressure with the finger shows no variation in color when the finger is raised, as in the case of a normal limb.

Gangrene may occur immediately, *i. e.*, within a few days or only gradually. If the artery has been torn a large pulsating swelling rapidly forms accompanied by signs of shock and internal hemorrhage. In a few cases such an aneurysmal tumor did not appear for several days to weeks after the injury.

Injury of nerves as a result of dislocation is more frequent than is injury of the vessels. Rupture of a nerve is quite rare, while a contusion occurs not uncommonly.

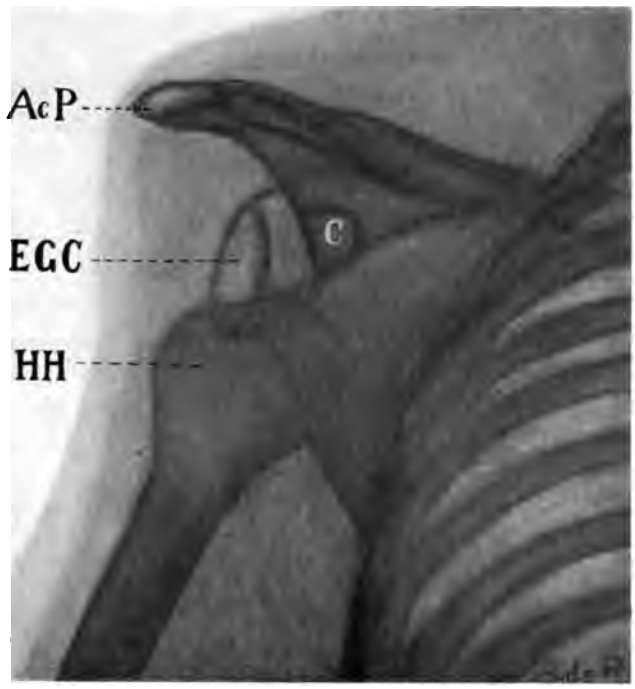


FIG. 338.—X-RAY OF SUBGLENOID DISLOCATION OF THE SHOULDER-JOINT.

C, Coracoid process, below which lies the head of the humerus (HH); EGC, empty glenoid cavity; AcP, acromion process of scapula. Note the flattening of the shoulder below the acromion process due to the absence of the head of the humerus.

The diagnosis of nerve injury can be readily made from the presence of the disturbances of sensation and motion characteristic of such injury (see page 498). In the upper extremity, paralysis of the musculospiral nerve is far more frequent than is that of all the other nerves. In the lower extremity the sciatic and anterior crural are occasionally involved.

Other complications of dislocations are: (*a*) injuries of the skin and other soft parts in compound dislocations; (*b*) the occurrence of atrophy of the muscles proximal and distal to the joint, as well as the formation

of adhesions within the joint; (*c*) fractures involving the articular ends of the bones which enter into the formation of the joint.

Diagnosis of Dislocations in General.—As in fractures, a diagnosis can be made from certain objective and subjective signs taken in conjunction with an accurate history of the manner in which the accident occurred.

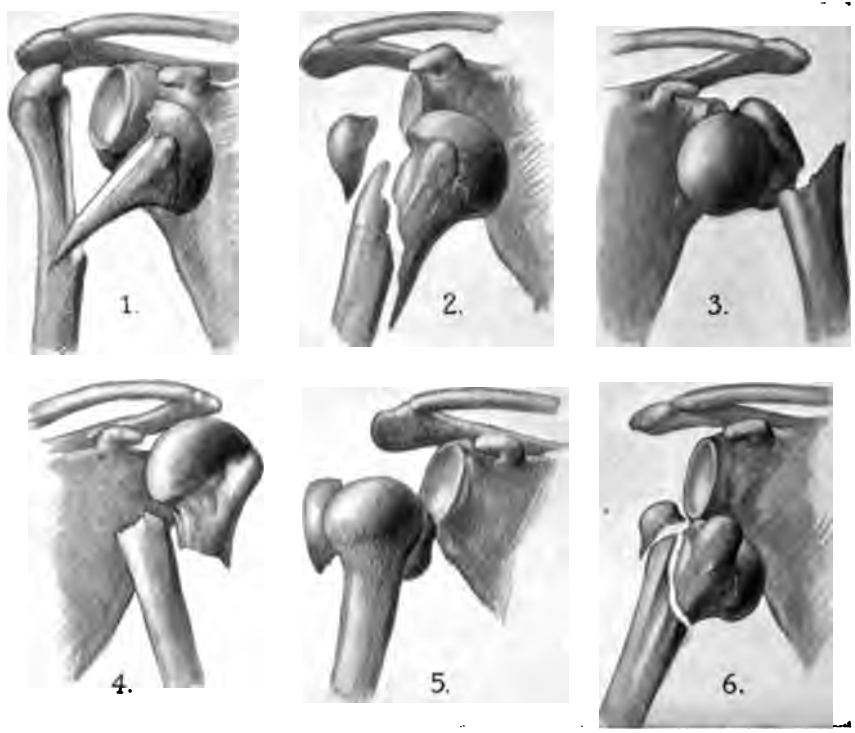


FIG. 330.—VARIOUS FORMS OF FRACTURES OF THE UPPER END OF HUMERUS ASSOCIATED WITH DISLOCATION OF THE HEAD OF HUMERUS (Robert Jones).

1, Split fracture of shaft of humerus with subcoracoid dislocation of head; 2, oblique fracture of upper end of humerus with subcoracoid dislocation and separation of greater tuberosity; 3, fracture of surgical neck of humerus, with dislocation of head: 4, fracture of surgical neck of humerus with displacement upward of head and inward of shaft; 5, subglenoid dislocation of humerus, with separation of greater tuberosity to outer side and lesser to inner side; 6, subglenoid dislocation of humerus with fracture of anatomic neck and separation of greater tuberosity. This illustration was made from skiagraphs.

The examination should be made by (*a*) inspecting the limb to ascertain the nature of the deformity; (*b*) palpating the parts, if possible, to learn the relation of the displaced articular ends to each other; (*c*) measuring the limb with the aid of certain fixed anatomic points (Fig. 331); (*d*) an *x*-ray examination if necessary to confirm the diagnosis of dislocation and to ascertain whether there is a complication in the shape of a fracture.

The *objective signs of a dislocation* are:

1. *Deformity.*—The position in which the limb is held is often so characteristic that a simple inspection will indicate the condition to the experienced eye. In stout individuals such a change in the axis of a limb or of its position is much more apt to be overlooked than in thinner individuals.

In general, the deformity may be said to be due (*a*) to a change in the

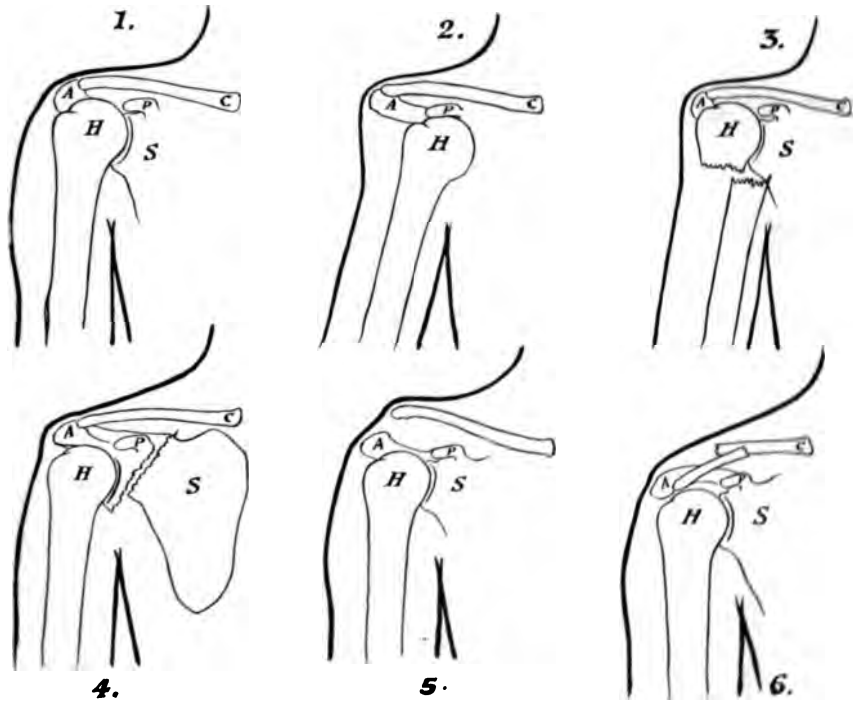


FIG. 340.—LESIONS TO BE CONSIDERED IN DIFFERENTIAL DIAGNOSIS OF SHOULDER INJURIES.

A, Acromion process of scapula; *P*, coracoid process of scapula; S, body of scapula; *C*, clavicle; *H*, humerus; 1, normal shoulder-joint, showing convexity due to presence of head of humerus in glenoid cavity, and to deltoid muscle; 2, subcoracoid dislocation of the humerus; 3, fracture of surgical neck of humerus, displacement of lower fragment inward. Note the flattening of the normal convexity of the shoulder in both 2 and 3. 4, Fracture of neck of scapula, permitting humerus to drop; 5, upward dislocation of acromial end of clavicle; 6, fracture of clavicle, with typical displacement of fragments.

direction or axis (Fig. 321) of the dislocated bone or bones; (*b*) to the abnormal position as determined by palpation (unless too much swelling exists) of the dislocated articular ends; (*c*) to the presence of an empty joint socket.

2. *Disturbance of Function of the Limb.*—The range of movement of a dislocated joint is usually limited. If any movements of the end of one of the bones forming the articulation are felt, they are at a point away from the normal joint.

DIFFERENTIAL DIAGNOSIS OF INJURIES OF SHOULDER (FIG. 310).

	Abnormal Prominences.	Convexity of Shoulder.	Position of Head.	Axis and Length of Arm.	Crepitus, Abnormal Mobility, Etc.
1. Sprain	None.	Unchanged.	Rotates in joint.	Unchanged.	Absent.
2. Dislocation outer end of clavicle	Prominence above acromion.	Unchanged.	Rotates in joint.	Unchanged.	Outer end of clavicle shows abnormal mobility above acromion.
3. Fracture acromion process	None unless marked displacement.	Acromion lower, otherwise unchanged.	Rotates in joint.	Unchanged.	Crepitus and abnormal mobility at outer end of acromion.
4. Fracture of spine of scapula (rare)	Acromion very prominent.	Depression beneath acromion.	Head felt in axilla, but rotates in joint and can be raised.	Axis unchanged, but arm apparently longer.	Distinct crepitus and abnormal mobility.
5. Fracture upper end of humerus (surgical neck or epiphysis)	Prominence of upper end of shaft below coracoid or acromion.	Shoulder somewhat flatter according to degrees of displacement.	Head in glenoid cavity, does not rotate with shaft.	Axis changed, more internal, arm shorter.	Unless impacted, get distinct crepitus and abnormal mobility in adults. Less marked in children.
6. Dislocation of humerus	Acromion prominent.	Depression or flattening beneath acromion.	Head felt below coracoid process or in axilla.	Axis changed, length increased.	Head fixed, adduction impossible. Only movable if tuberosities broken.

3. *Change in Length of the Limb.*—In many of the hip and shoulder dislocations (Figs. 337, 387) there is a shortening of the distance between the generally accepted fixed bony points on the dislocated side. The absence of any difference in length usually means only a partial dislocation (subluxation).

4. *X-ray Examination.*—This is not employed as often as in the case of fractures, owing to the fact that the deformity and other objective signs usually enable a diagnosis to be made.

It should, however, be used wherever there is any difficulty in reduction to determine whether a fracture coexists.

When the patient is stout or the swelling appears early and is very marked, a skiagraph is of the greatest possible aid.

FIG. 341.—METHOD OF EXAMINATION OF FRACTURES OF THE SURGICAL NECK OF THE HUMERUS.

The left hand grasps the arm close to the point of fracture in the case of the right arm, and vice versâ in the case of the left arm, while the forearm of the patient is allowed to rest upon the outstretched palm of the examiner. By carrying the forearm and lower fragment alternately away from and toward the body the false point of motion and crepitus can readily be elicited.

SPECIAL FRACTURES AND DISLOCATIONS.

Shoulder Region.—In the examination of a patient to ascertain the nature of an injury to the shoulder region, the following conditions must be thought of and eliminated by exclusion in the order named:

1. Fractures of the clavicle (most often in middle third).
2. Dislocations of the clavicle at the sternal or acromial ends (latter most common).
3. Fractures of the scapula (most often in acromion process).
4. Fractures of the upper end of humerus (usually at surgical neck).
5. Dislocation of the shoulder-joint (subcoracoid most frequent).

The principal diagnostic features of these various injuries follow:

1. **Fractures of the Clavicle.**—About one-half of these occur in the middle third of the bone, and a third of the remainder at the junction of the outer and middle thirds of the bone. Incomplete fractures of the greenstick variety are quite common in children, and not infrequently

escape recognition until a callus has begun to form. Fractures of the middle third, when complete and associated with displacement of fragments (Fig. 343), are easily diagnosed. On passing the finger along the anterior or upper surfaces, the projection of the overlapping fragments, or the formation by them of an angle directed backward, can be readily felt. The other signs of fracture, crepitus and a false point of motion, can be demonstrated, if necessary, by alternately raising and lowering the arm when grasped at the elbow-joint (Fig. 342). At times it is necessary to draw the shoulder back in order to obtain crepitus.

FIG. 342.—METHOD OF EXAMINATION OF A FRACTURE OF THE UPPER OR MIDDLE THIRD OF THE SHAFT OF HUMERUS.

The right hand in the case of an examination of the left humerus is placed over the seat of fracture, the elbow is permitted to rest upon the opposite hand, the arm being moved alternately toward and away from the body in order to determine abnormal mobility and crepitus.

The diagnosis of fractures which are complete but not associated with displacement, as well as of greenstick (incomplete) fractures, is not as easy. In such cases one is guided by the history of the mode of injury (fall upon the shoulder or outstretched hand) and the results of palpation. The latter shows great tenderness at the point of fracture and there is pain on raising the arm voluntarily, referred to this spot. In many cases, a slight elevation of the surface of the bone is present at the point of greatest tenderness.

Multiple and comminuted fractures of the clavicle are quite rare, and can be recognized by feeling the separate fragments and by the use of the *x*-ray (Fig. 327).

Fractures near the sternal or clavicular ends of the clavicle are often associated with considerable displacement of fragments and may simulate a dislocation of the clavicle (Fig. 329). In the case of a fracture there is distinct crepitus, and the point at which abnormal mobility exists is situated close to the sternoclavicular and acromioclavicular joints respectively. The joints themselves are found to be intact, by placing a finger over

them while the arm is alternately raised and lowered. A familiarity with the anatomic relations, as gained by palpation on normal subjects during life, is invaluable in the diagnosis of injuries of the bones and joints.

In cases of doubt, especially if the injury is at the acromioclavicular

FIG. 343.—X-RAY OF PSEUDARTHROSIS OF FRACTURE, MIDDLE OF SHAFT OF HUMERUS, THE EXTERIOR PICTURE OF WHICH IS SHOWN IN FIG. 341.

This *x*-ray was taken five months after the injury; the *x*-ray shows practically no callus formation (fibrous union).

joint, a skiagraph should be taken. In the greenstick fractures of children the callus is usually excessive in size for the first eight to twelve weeks and then gradually disappears.

2. Dislocations of the Clavicle. —*Dislocations of the sternal end* are much rarer than are those of the acromial end. Dislocation at the sterno-

clavicular joint occurs in three forms: (*a*) a forward, which is the most common; (*b*) a backward, and (*c*) an upward. In each of these the diagnosis should be readily made unless great swelling exists. The unattached end of the clavicle is felt either in front, behind, or above its normal position. In addition, there is localized pain, and in the backward variety there may be signs of pressure upon the trachea or upon the vessels at the lower part of the neck.

Dislocation at the acromioclavicular joint occurs (*a*) upward (supra-acromial); (*b*) downward and backward (subacromial), and (*c*) down-

FIG. 344.—ANKYLOSIS OF SHOULDER-JOINT (PARTIAL), FOLLOWING FRACTURE OF THE UPPER THIRD OF THE HUMERUS.

The left arm is shown so that it can be compared with the right or injured arm. The amount of abduction of the left or uninjured arm was normal. On the right or injured side the arm could be abducted only to the distance of about forty five degrees from the body. The illustration also shows a well-marked flexion contracture due to non-use of the elbow-joint.

ward and forward under the coracoid process (subcoracoid). Of these, the second and third are so rare, that one need but consider the first variety clinically. This may exist in either an incomplete or a complete form. In the former, the clavicle can be felt to be raised slightly above the level of the acromion and can be forced back in place by pressure. Upon removing the finger the bone springs back again. In the complete variety there is quite a gap to be felt between the outer end of the clavicle and the acromion process (Fig. 329). By pressure upon the clavicle, the latter can be brought toward the acromion, but can only be

held there with difficulty. The amount of functional disturbance and local pain varies greatly, being very marked in some cases.

3. **Fractures of the Scapula.**—Fractures of this bone may occur either through the body, inferior and superior angles, spine, acromion, coracoid, surgical neck, and glenoid cavity. Of these, all except fractures of the body, acromion, and spine are so rare as to be of little importance clinically. *Fractures of the body of the scapula* may be suspected from the history of a blow or other direct violence over the scapular region, followed by pain localized over the body of the scapula and increased by any move-

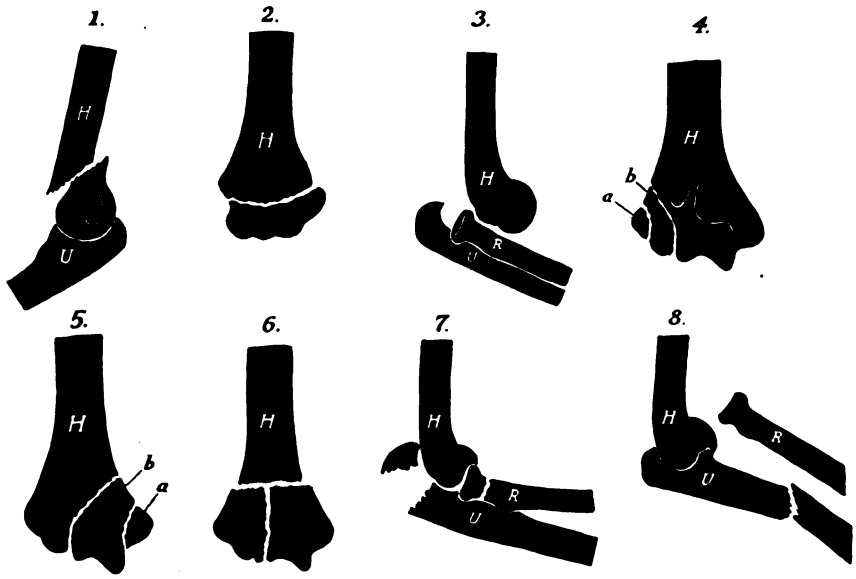


FIG. 345.—MOST FREQUENT FORMS OF INJURY OF THE BONES COMPRISING THE ELBOW-JOINT.

H, Humerus; *R*, radius; *U*, ulna. 1, Supracondyloid fracture of humerus; 2, epiphyseal separation of the lower end of humerus; 3, backward dislocation of both bones of forearm; 4, fracture of internal epicondyle (*a*) and of internal condyle itself (*b*); 5, fracture of external epicondyle (*a*) and of external condyle (*b*); 6, T-shaped fracture of lower end of humerus; 7, fracture of olecranon and of neck of radius; 8, fracture at junction of upper and middle shafts of ulna, combined with forward dislocation of head of radius.

ment of the arm. The outline of the bone can be felt to be irrgeular, and by grasping the lower angle one can obtain crepitus and abnormal mobility. In many cases this is either difficult or impossible, on account of the pain and swelling, so that reliance must be placed upon palpating an irregularity and the presence of severe pain on pressure and movement.

Fractures of the acromion process, like those of the body of the bone, are very difficult to recognize by palpation. The use of the *x*-ray has been of great aid in the diagnosis of these fractures. On passing the finger backward from the tip of the process, one can at times feel a depression corresponding to the displacement of the fragments. Crepitus

and abnormal mobility are obtained by alternately raising and lowering the arm, which is grasped at the elbow (Fig. 328), while the finger is placed over the acromion process. There is usually inability to raise the arm.

The most frequent locations of these fractures are either at the base or tip of the acromion process. *Fractures of the surgical neck of the scapula* are very rare. They simulate dislocations of the shoulder on account of the dropping of the humerus (Fig. 340) with marked concavity below the acromion process. When the arm is raised the latter deformity disappears, the manipulation being accompanied by crepitus. An *x*-ray will readily clear up the diagnosis.

FIG. 346.—METHOD OF GRASPING SCAPULA TO DETERMINE FRACTURE OF SAME.

4. Fractures of the Upper End of the Humerus.—Before attempting the diagnosis of an injured shoulder one should accustom one's self, either by previous training or examination of the normal shoulder, to palpate the most important points in the applied or clinical anatomy of the normal shoulder. These are: (*a*) palpation of the acromion process and its relation to the clavicle; (*b*) determination of the fact that the head of the humerus rotates in the glenoid cavity (Fig. 330); (*c*) palpation of the normal convexity of the shoulder due to the deltoid muscle and the head of the humerus; (*d*) measurement from the tip of the acromion process to the external condyle of the humerus (Fig. 331); (*e*) extent of normal movements of the shoulder-joint (abduction, adduction, extension in a forward and backward direction); (*f*) study of an *x*-ray of a normal child's and adult's shoulder-joint.

The possible injuries at the upper end of the humerus which must be taken into consideration are: (1) Fracture of the anatomic neck alone or associated with fractures of the tuberosities; (2) epiphyseal separation; (3) fracture of the surgical neck without impaction; (4) impacted

fracture of the surgical neck; (5) any of the above fractures of the upper end of the humerus, combined with dislocation of the head.

Fracture of the anatomic neck is almost always associated with fracture of the tuberosities and cannot be distinguished clinically from fracture of the surgical neck except by an *x*-ray examination. Isolated fractures of the tuberosities are also comparatively rare. Those of the greater tuberosity often accompany a dislocation of the shoulder or a fracture of the anatomic neck. When it occurs independently of such an injury the diagnosis may be made if one can palpate a loose fragment corresponding to the greater tuberosity and can cause pain by pressure and upon rotating the arm outward. Nieszytka,[1] has called attention to the fact that an isolated fracture of the greater tuberosity is frequently found upon *x*-ray examination in cases previously diagnosed as sprains or contusions of the shoulder.

FIG. 347.—TYPICAL SWELLING OF ELBOW-JOINT IN A CHILD OF FIVE, FOLLOWING A FALL UPON THE ARM, ILLUSTRATING THE DIFFICULTIES OF DIAGNOSIS. (See text.)

Only a few cases of fracture of the lesser tuberosity have been reported as an isolated injury. It is usually an accompaniment of a dislocation of the shoulder or of a fracture of the greater tuberosity, or of those fractures of the anatomic neck, in which the shaft is impacted between the head and tuberosities.

Lorenz[2] reported a case of fracture of the lesser tuberosity which followed forced outward rotation of the arm. Sixteen months after the injury when first examined by Lorenz internal rotation was impossible, and on palpation a sharp edge of bone was evident at the location of the lesser tuberosity.

Epiphyseal separation at the upper end of the humerus occurs most frequently between the ages of nine and sixteen. The diagnosis in cases

[1] "Deutsche Zeitschrift für Chirurgie," vol. lxxxii.

[2] Ibid., vol. lviii, S. 523.

without displacement is very difficult and can be made only by the presence of pain on pressure, or pain and soft crepitus upon rotation of the humerus, localized at the level of the epiphyseal cartilage. In some of these cases displacement is likely to take place after a few days if the arm is not immobilized.

In cases with either primary displacement or the above referred to secondary displacement, the diagnosis can be made either by palpation, if the swelling is not too great, or by an *x*-ray examination.

FIG. 348.—METHOD OF DETERMINING THE RELATION OF THE THREE BONY POINTS AT THE BACK OF THE ELBOW IN EXAMINATIONS FOR FRACTURES OR DISLOCATIONS OF THE BONES WHICH FORM THE ELBOW-JOINT.

In the case of an examination of the left elbow, as shown here, the patient's left forearm is allowed to rest upon the left forearm of the examiner, while the latter's right hand supports the elbow in such a manner that the thumb rests upon the external condyle, the middle finger upon the internal condyle, and the index-finger upon the tip of the olecranon. The relation of these three points is shown in the illustration when the elbow is flexed that is, the tip of the olecranon lies a little below the dotted line joining the two condyles. When the arm is extended the tip of the olecranon lies either in this line or above it.

On palpation, one feels the normal convexity of the shoulder, because the head is still in the glenoid cavity, thus distinguishing the injury from a dislocation. The upper end of the diaphysis or shaft is to be felt over the coracoid process, an inch or more below the acromion. This point rotates with the remainder of the shaft and can be rendered more prominent by raising the shoulder. The displacement is usually forward

and inward (Fig. 333). Upon manipulation crepitus can frequently be felt where the head and upper end of the displaced shaft meet. In the differential diagnosis one must consider: (*a*) dislocation of the humerus forward and (*b*) fracture of the surgical neck. Epiphyseal separations can occur only at a time of life when dislocations of the shoulder-joint are very infrequent. The end of the shaft in an epiphyseal separation with displacement is convex and rather smooth, and may easily be mistaken for the head. The latter, however, is always smoother and rounder than the broken upper surface of the diaphysis, and the skin is not so often firmly fixed over it as in an epiphyseal separation. The normal rotundity of the shoulder is also present in the latter. A differentiation from fracture of the surgical neck is often impossible without an *x*-ray.

FIG. 340.—POSTERIOR VIEW OF NORMAL ADULT ELBOW-JOINT (*x*-ray).

H, Humerus; R, radius; U, ulna. The arrow points to the clear space seen in such views, which corresponds to the olecranon fossa, and is not to be interpreted as a fracture.

Fractures of the surgical neck of the humerus include all fractures in the upper fourth of the bone below the epiphyseal line. As in the cases of epiphyseal separation, the diagnosis is difficult or easy according to the degree of displacement. In both instances the head of the bone is found to rotate in the glenoid cavity by grasping it between the fingers. On rotating the shaft in cases without displacement, the head fails to participate in the movement, and there is pain, crepitus, and abnormal mobility at the point of fracture.

If impaction of the fragments exists, all of these signs are absent and the diagnosis can only be made from the history of the mode of injury, the presence of localized pain upon rotation, loss of function of the arm,

and an *x*-ray (Fig. 335). In cases with moderate or more marked displacement the ends of the fragments and their relation to each other can be felt in thin subjects by following the shaft upward. Abnormal mobility and crepitus are usually quite easily elicited. There is often a change in the axis of the arm (Fig. 336), as in a dislocation, but the presence of the head in the glenoid cavity and of the normal contour or convexity of the shoulder will exclude dislocation. The coexistence

FIG. 350.—METHOD OF PALPATION OF HEAD OF RADIUS.

In examining the head of the radius of the left arm as shown in the illustration, the surgeon grasps the patient's hand with his own left hand as though he were shaking hands. The surgeon then grasps the head of the radius (which is to be found just beneath the external condyle of the humerus) between the thumb and index-finger of the right hand. The patient's forearm is alternately supinated and pronated while the surgeon's right hand can feel the rotation of the head of the radius. On the right side the hands of the examiner are simply reversed.

of fracture of the surgical neck and dislocation of the shoulder is referred to later.

Dislocations of the shoulder-joint occur in the following directions:

1. Forward or anterior—Subcoracoid (quite common form); subclavicular (rare).

2. Downward—Subglenoid (rare).

3. Backward or posterior—subacromial (rare); subspinous (very rare).

4. Upward—Supraglenoid (very rare).

Subcoracoid Dislocation.—(*a*) The normal convexity is lost and one can see a distinct flattening or even a depression below the acromion process (Fig. 337) when looked at while standing in front of or behind the patient.

(*b*) There is a prominence below the outer end of the clavicle at the coracoid process.

FIG. 351.—METHOD OF EXAMINING THE LOWER END OF THE HUMERUS IN CASES OF FRACTURE AT THIS POINT.

The forearm, when one is examining the right arm, is grasped by the left hand, the hand of the patient being allowed to rest upon the forearm of the examiner, while the right hand of the examiner grasps the region of the lower end of the humerus. For the examination of the left humerus, the hands should be reversed.

(*c*) The arm is abducted, the elbow often being three to four inches from the chest.

(*d*) The axis of the humerus is changed so that instead of being nearly parallel with that of the opposite side, an imaginary line drawn through the dislocated humerus meets that of the corresponding bone of the opposite arm a little beyond the head (Fig. 337).

(*e*) There is a lengthening of the arm as measured from the acromion to the external condyle (Fig. 331).

(*j*) On palpation one feels the depression below the acromion and the empty glenoid cavity is felt by pushing the fingers in deeply.

(*g*) The head can be felt beneath the coracoid process.

(*h*) The arm is more or less fixed, permitting of but slight, if any, abduction or rotation.

Subglenoid Dislocation.—The *symptoms of a subglenoid dislocation* are that the head can be felt through the axilla, lying beneath the glenoid cavity and the abduction of the arm is more marked. In *the subclavicular form*, the head is to be felt at the point where the pectoralis major and deltoid meet and the arm is greatly adducted. In the *subacromial and subspinous or backward forms*, in addition to the flattening of the

FIG. 352.—DEFORMITY FOLLOWING SUPRACONDYLOID FRACTURE OF THE HUMERUS.

The illustration shows how the lower fragment, HL, is displaced backward and upward, and the upper fragment downward and forward HU, causing it to become prominent at the bend of the elbow. (See text.) R, Radius; U, ulna. 1, Upper epiphysis of radius; 2, epiphysis corresponding to olecranon process; 3, lower epiphysis of humerus.

shoulder and the empty glenoid cavity, one can see and feel the head of the humerus beneath the prominent acromion process or even further back.

Diagnosis of Fractures Associated with Shoulder Dislocations (see Fig. 339).—When a fracture of the surgical or anatomic neck of the humerus accompanies a dislocation, the diagnosis can often be made without a skiagraph by the facts, that in addition to the flattening of the shoulder and palpation of the head in an abnormal position, which are characteristic of a dislocation, the head of the humerus does not rotate with the shaft. Fractures of the tuberosities associated with dislocation of the head cannot be recognized without the use of the *x*-ray. The same

is true of fracture of the glenoid cavity unless the injury is so extensive as to cause recurrence of the dislocation after its reduction.

Fractures of the Shaft of the Humerus.—In this are included all fractures occurring between the insertion of the deltoid above and the upper portion of the supracondyloid ridges below. The diagnosis can be made in the majority of cases by manipulation of the arm (Fig. 342), especially if there is some degree of dislocation. The ordinary signs of fracture, such as crepitus, abnormal mobility, loss of function, localized pain, are all quite marked. If there is considerable displacement of fragments, the lower portion of the arm may form an angle with the upper and the ends of the fragments are visible and easily felt.

FIG. 353.—X-RAY OF EPIPHYSEAL FRACTURE THROUGH THE LOWER EPIPHYSIS OF THE HUMERUS IN A CHILD OF THREE.

The outlines of the bones have been strengthened by tracing them in black. RS, Shaft of radius; R, center for capitellum of humerus; US, shaft of ulna; E, lower epiphysis of humerus displaced inward; H, shaft of humerus.

The greatest interest in connection with fractures of the shaft of the humerus is in connection with injuries of the musculospiral nerve or laceration of the brachial artery. The diagnosis of these complications has been previously discussed (page 524). Delayed union is very frequent in this form of fracture and can be recognized by the persistence of abnormal mobility and the absence of ossification at the point of fracture (Fig. 343), as shown in a skiagraph.

Injuries in the Vicinity of the Elbow-joint.—In the examination of a person suffering from an injury of the elbow-joint the following possible lesions must be thought of and one excluded after the other by a systematic exami[redacted] if required, with the use of the *x*-ray.

1. *Fractures of lower end of humerus.*

(*a*) Supracondyloid fracture (more or less transverse of shaft above condyles).

(*b*) T- or Y-shaped fractures.

(*c*) Epiphyseal separation.

(*d*) Fractures of external or internal condyles and epicondyles.

2. *Lesions of the radius and ulna:*

(*a*) Dislocation backward of radius and ulna.

(*b*) Fracture of upper third of ulna with or without dislocation forward of radius.

(*c*) Dislocation forward of upper end of radius.

(*d*) Fracture of olecranon process of ulna.

(*e*) Fracture of neck or head of radius.

(*f*) Subluxation of head of radius.

FIG. 354.—FROM A DRAWING OF AN *x*-RAY OF A FRACTURE OF THE OLECRANON PROCESS.

3. *Simple sprains of the elbow.*

In the majority of cases swelling occurs so rapidly after elbow injuries that palpation is difficult. In children especially the administration of an anesthetic is advisable in order to make a diagnosis.

Familiarity with the surface anatomy of the elbow region will be of great aid in an examination for possible injury. The more important normal landmarks are: (*a*) The two condyles of the humerus and the tip of the olecranon process form an equilateral triangle when the arm is flexed to a right angle. When the arm is extended they lie in a straight line (Fig. 348). (*b*) The head of the radius can be felt to rotate below the external condyle of the humerus (Fig. 350). (*c*) An angle is formed by the radius and ulna with the humerus when the hand and forearm are held in a supinated position, which is known as the *carrying angle*.

If the two condyles of the humerus lie in their normal relation to the olecranon process as determined by palpation, this will exclude a dislocation of both bones of the forearm, a fracture of either condyle or a fracture of the olecranon process.

If the head of the radius can be felt to rotate in its normal position

(Fig. 350), this will exclude a fracture of the neck or head of the radius and a dislocation of the radius.

The chief diagnostic points of the various injuries in the vicinity of the elbow-joint are as follows:

I. (*a*) *Supracondyloid Fracture of the Humerus.*—These occur oftener during the early period of life. Kocher has shown that there are two varieties, viz., an extension and a flexion fracture. In the former the injury follows a fall upon the outstretched hand, and the line of fracture is oblique from behind, downward and forward. The upper fragment is displaced downward and forward so that its sharp end is often fixed

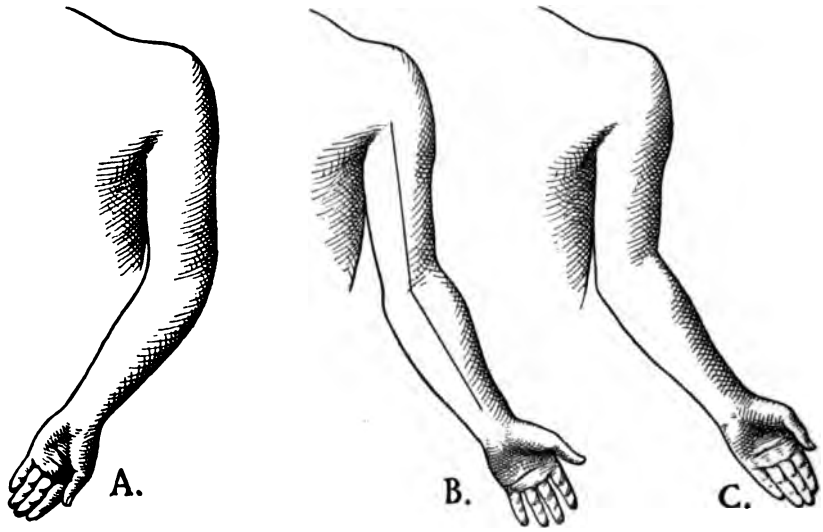


FIG. 355.

A Cubitus varus deformity; B normal carrying angle of arm; C, cubitus valgus deformity.

in the skin on the front of the elbow or actually penetrates it. It is apt to be accompanied by laceration of the brachial artery and by severing or compression of the median, ulnar, and radial nerves. In the flexion variety the upper fragment is displaced backward and the lower, upward and forward, the deformity resembling that of a backward dislocation of the elbow. 1. Deformity may be present or not according to the degree of displacement. If the displacement is marked, there is a prominence at the back of the elbow in those fractures which follow a fall upon the elbow. These are called extension fractures, follow a fall upon the outstretched hand (Fig. 352). They resemble a dislocation backward of the radius and ulna, but palpation shows the relations of the olecranon

to the condyles to be normal (Fig. 348). The lower end of the upper fragment is often prominent and easily felt a little above the bend of the elbow. The deformity can usually be readily corrected by downward traction.

2. Abnormal mobility and crepitus are easily elicited by grasping the forearm and lower end of the humerus and moving it firmly forward and backward while the shaft of the humerus is steadied with the other hand or by an assistant (Fig. 351).

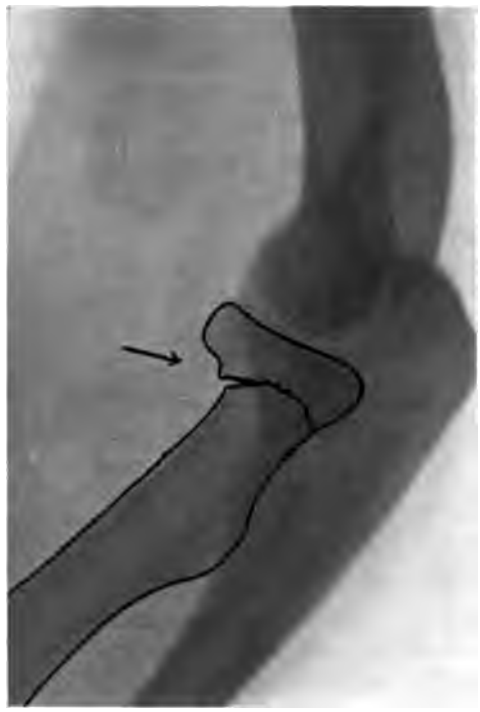


FIG. 356.—X-RAY OF FRACTURE OF THE NECK OF THE RADIUS IN A VERY MUSCULAR INDIVIDUAL.

The arrow points to the point of separation of the capitellum and shaft.

1. (*b*) *Intercondyloid or T or Y Fractures of Lower End of Humerus.*—In this form of injury an *x*-ray is often necessary in order to make an exact diagnosis. These are often compound, so that a direct inspection is possible. The signs are the same as for supracondyloid fracture, but the relation of the condyles will be changed according to the degree of displacement. In some cases the condyles are so widely separated that the olecranon passes between them. Unless the swelling is too great, the condyles can be moved independently of each other and of the shaft. In some cases the median nerve has been contused by being stretched across the displaced fragments.

1. (*c*) *Epiphyseal Separation.*—In order to understand this class of cases it is necessary to remember that the lower end of the humerus develops from four separate centers of ossification. The first to appear is that of the capitellum, in the third year. The next is the internal epicondyle, in the fifth year. The centers in the trochlea and external epicondyle appear in the eighth year, according to Wolff.

Epiphyseal separation is usually produced by direct violence, such as

a fall upon the elbow while bent or the passage of a wheel or a kick from a horse. Indirect violence, such as a fall upon the outstretched hand, is less apt to cause it. After the eighth year, a displacement of the capitellum and external epicondyle may occur together. After the thirteenth year there are only possible epiphyseal separations of the three coalesced nuclei (external epicondyle, capitellum, and trochlea) and the internal epicondyle. From the sixteenth or seventeenth year and up to the eighteenth or nineteenth only epiphyseal separation of the internal epicondyle is possible. Up to the eighteenth year, when there is a fracture in the neighborhood of the elbow-joint, the chances of its being epiphyseal are about 25 per cent. After the eighteenth year a separation of the capitellum and external epicondyle is called a fracture of the external condyle in adults, while separation of the trochlea and internal condyle is called a fracture of the internal condyle in adults. Isolated separation of the capitellum and trochlea together is rare. The lower fragment is usually displaced backward, as in supracondyloid fractures.

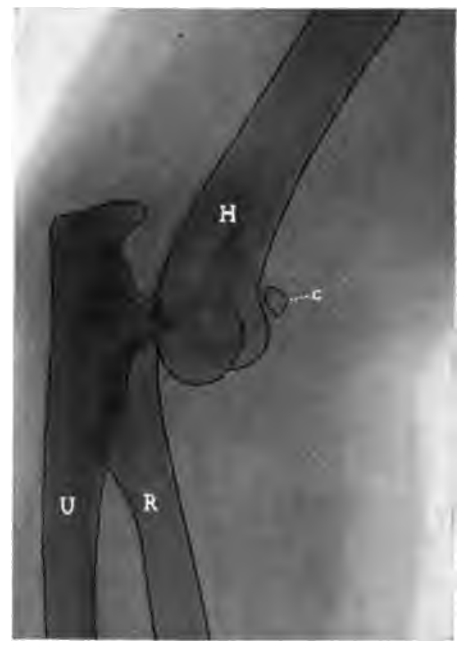


FIG. 357.—SKIAGRAPH OF CASE OF DISLOCATION BACKWARD OF BOTH BONES OF FOREARM.

U, Ulna; R, radius; c, broken-off coronoid process of ulna; H, shaft of humerus. Note in the shadow the obliteration of the normal depression above the olecranon process. (See text.)

The signs are those of supracondyloid fracture, and it occurs in children below the age of ten. It may involve the entire epiphysis only, at a very early age (Fig. 345), resulting in lateral or antero-posterior displacement, as in the typical supracondyloid form in older children and adults. The crepitus is usually muffled or indistinct.

A fracture through the epiphysis can be distinguished from a dislocation of the elbow by the fact that the bony points on the lower fragment of the humerus still retain their normal relation to the olecranon. It differs from the supracondyloid fracture of older children and adults in showing a prominence, due to displacement forward of the upper frag-

ment. This prominence is found at a lower level than in the supracondyloid variety.

One should, in general, never make a diagnosis from an *x*-ray of an elbow-joint injury in children without referring frequently to *x*-ray pictures of the normal joint at various ages. The presence of a clear area caused by a normal cartilage may often lead one to think it a fracture line.

I. *(d) Fractures of the Internal Epicondyle and Internal Condyle.*—Fractures of the internal epicondyle usually occur between the ages of

FIG. 358.—FORWARD DISLOCATION OF RADIUS, IN A BOY OF TEN.

Compare with the normal elbow of same patient shown in Fig. 325. R, Shaft of radius; U, shaft of ulna; H, shaft of humerus 1, Upper epiphysis of radius (capitellum); 2, upper epiphysis of ulna, which forms the olecranon process; 3, lower epiphysis of humerus.

ten and twenty. They are nearly always separations of the epitrochlear epiphysis.

In fractures of the internal condyle, the latter can be moved to and fro independently of the shaft, by grasping it between the thumb and index-finger. This abnormal mobility is accompanied by crepitus. One of the most characteristic signs, if any displacement of the fragment has occurred, is the fact that when the relation of the three bony points is looked for, the internal condyle is found above the level of the external condyle (Fig. 348). There is lateral mobility of the elbow-joint.

I. (*e*) *Fractures of the External Epicondyle and External Condyle.*—The former are rare and so difficult to recognize that for practical purposes it is only necessary to consider the fractures of the external condyle itself. The latter occur more frequently than those of the internal condyle, especially in young persons. The fragment broken off includes the epicondyle, outer portion of the trochlea, and capitellum (Fig. 360). It may be tilted or even rotated so that the broken surface looks upward or outward. The external condyle is found displaced upward when the three bony points at the back of the elbow are palpated. The fragment can usually be grasped between the fin-

FIG. 359.—LATERAL VIEW OF CASES OF OLD (TEN YEARS' DURATION) FRACTURE OF EXTERNAL CONDYLE OF HUMERUS CAUSING CUBITUS VALGUS DEFORMITY.

Note the upward displacement of the external condyle and radius.

FIG. 360.—ANTEROPOSTERIOR VIEW OF SKIAGRAPH OF CASE SHOWN IN FIG. 359.

Showing how the cubitus valgus resulted from the upward displacement of the outer condyle fragment.

gers and moved independently of the shaft, accompanied by crepitus. In some cases a deformity is visible.

II. (*a*) *Fractures of the Upper End of the Ulna and Radius.*—Fractures of the olecranon process of the ulna can be readily recognized if there is a considerable separation of the fragment from the main portion of the bone. This condition is seldom present in sufficient degree to be relied upon for diagnosis. If it exists a gap or depression can be felt between the fragment and the shaft, and the former possesses independent mobility.

If no separation exists one should search for mobility of the end of the olecranon by moving it laterally and also holding it between the fingers while an assistant alternately flexes and extends the forearm. Voluntary extension of the elbow-joint is usually absent and is a characteristic sign. If the swelling is great the presence of an olecranon fracture should be suspected from the inability to extend the arm voluntarily and also from the localized pain.

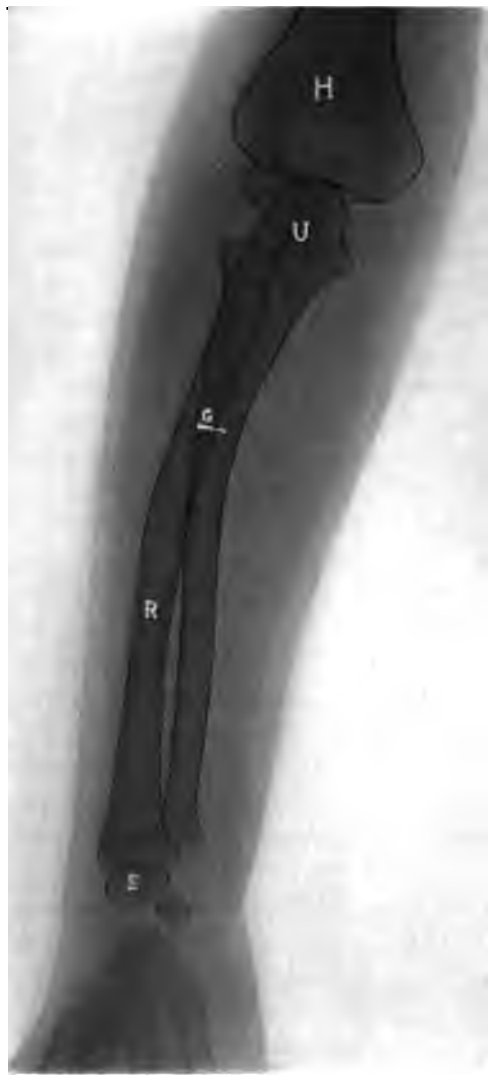


FIG. 301.—X-RAY OF CASE OF GREENSTICK FRACTURE OF THE ULNA, SHOWING THE CHARACTERISTIC BENDING OF THE BONES OF THE FOREARM.

The outlines of the bones have been strengthened by tracing them in black, and the light space in the ulna, shown at G, represents the incomplete line of fracture on the convex side of the ulna. The skiagraph was taken so that the back of the forearm is shown. R, radius; U, ulna; E, lower epiphysis of radius; H, humerus.

If possible, an *x*-ray should be taken at the earliest moment in these cases. Fractures of the coronoid process of the ulna, although rare, occur more frequently than was formerly thought. About twenty cases have been reported. It is usually associated with backward dislocation of the ulna and radius. It renders the reduction of the latter easier, but there is greater tendency to recurrence. It probably occurs quite often, and must be searched for by *x*-ray examination in all severe injuries of the elbow-joint. Dislocation of the fragment and resultant excessive callus formation may greatly interfere with the function of the joint.

Fractures of the Head and Neck of the Radius.—The recognition of this fracture is usually difficult. In the case shown in Fig. 356 the lesion was suspected from the presence of great pain over the head of the radius when it was grasped between the fingers, while the forearm was alternately pronated and supinated (Fig. 350). In some cases the head will be found not to move when the shaft is rotated, and there may be crepitus. At the present time the use of the *x*-ray has been found of the greatest service in the diagnosis of such fractures. Instead of being rare, these fractures of the head or neck of the radius are found by *x*-ray examination to be quite frequent. Many of the cases are treated as sprains unless a skiagraph is made.

FIG. 362.—GREENSTICK FRACTURE OF THE ULNA SHOWN IN FIG. 361, AFTER REDUCTION.

R, Shaft of radius; E, lower epiphysis of radius; U, shaft of ulna; C, callus at point of greenstick fracture, showing the relatively large size of these in such cases.

Dislocations of the Bones of the Forearm.—Dislocation of both radius and ulna backward (Fig. 357) or of the radius alone forward occurs far more frequently than any other varieties of dislocation. The following classification is the most generally accepted one: (1) Dislocation of both bones of the forearm: (*a*) backward; (*b*) lateral; (*c*) forward (with or without fracture of the olecranon; (*d*) divergent (antero-posterior and transverse). (2) Dislocations of the ulna alone (backward and upward). (3) Dislocations of the radius alone (forward, backward, and outward). The backward dislocations of both bones are, at times, complicated by fracture of the olecranon, of the coronoid process, of

the head, shaft, and lower end of the radius, or of the internal condyle of the humerus.

Dislocations of both bones of the forearm backward are recognized by careful attention to the results of palpation of the three bony points at the back of the elbow. The tip of the olecranon will be found either on a line with or above the level of the two condyles of the humerus. The olecranon also lies in a plane which is considerably further behind the humerus than in the normal arm. The head of the radius can be felt, and often seen, lying behind the external condyle of the humerus. The lower end of the shaft of the latter bone can be felt as a projection at the front of the elbow-joint. The arm is held in a semiflexed position and there is great limitation of movements in the elbow-joint. *Dislo-*

FIG. 363.—CHARACTERISTIC SWELLING OF WRIST-JOINT AND DEFORMITY IN RECENT COLLES' FRACTURE.

Note the fullness on the flexor surface of wrist, due to displacement downward of the upper fragment of the radius, and the more distal prominence on the dorsal surface of the wrist, due to displacement upward of the lower fragment of the radius. Note also the swelling and obliteration of the normal depressions corresponding to the wrist-joint.

cation of the radius alone is usually of the forward variety. It may at times be complicated by fracture of the upper third of the shaft of the ulna. Both active and passive movements of the elbow are painful and limited, especially flexion. Upon examining the elbow in the systematic manner referred to, the head of the radius is not found in its normal position. Instead of the head, one finds a depression on deep alpation; the head itself is felt in front of the lower end of the humerus on the radial side of the bend of the elbow.

In older cases when the swelling has disappeared, the head of the radius may project considerably above the level of the surrounding tissues. In the cases associated with fracture of the ulna the latter can be recognized by palpation of the deformity when the finger is passed along the back of the ulna, and also by the presence of abnormal mobility.

Subluxation of the radius, or "pulled elbow," occurs in a young child after lifting it by the forearm or pulling upon the hand. There is no palpable or visible displacement of the radius. The child will not use the arm and it either hangs by its side or is supported by the other one. There is pain on pressure over the head of the radius and the child resists any rotary movements of the forearm, especially supination. In the majority of cases a separation can be felt between the lower end of the humerus and the head of the radius. After forced supination a slight click is heard and the child uses the arm freely again.

Ancient or Unreduced Dislocations of the Elbow.—As in the case of the shoulder-joint, a dislocation of the elbow may be first seen after it has remained in an unreduced condition for weeks to months. The ends of the displaced bones become surrounded with cicatricial tissue and new bone formation occurs between the ends.

Fractures of the Shafts of the Ulna or Radius.—Fractures of both bones of the forearm may occur simultaneously or either one alone may be broken. In children the *greenstick or incomplete* form (Fig. 362) is by far the most frequent and is often overlooked. As in the case of the complete fracture in adults, it usually occurs in the middle third. It may involve one or both bones. If after a fall upon the forearm or outstretched hand a child complains of pain or does not use the arm, a search for an incomplete fracture should be made. The radius and ulna can be palpated in children throughout almost their entire length, so that a bowing or angle is readily detected. The other signs are localized pain and tenderness. An *x*-ray examination should be made in every suspected case. One bone may be completely broken and the other only incompletely. Complete fractures of either or both bones of the forearm are not difficult to recognize unless the individual is very muscular or very fat. When the arm is grasped in the manner shown in Fig. 368, abnormal mobility and crepitus can be readily detected. At times the diagnosis may be made from the deformity alone, which is either visible or can be felt by palpating the bones.

Injuries in the Vicinity of the Wrist-joint.—The following conditions must be thought of in this region:

(*a*) Fractures of the lower end of the radius.
(*b*) Fracture of the styloid process of the ulna.
(*c*) Fracture of both radius and ulna near the wrist.
(*d*) Fractures and dislocations of the carpal bones.
(*e*) Dislocations of the wrist-joint.
(*f*) Carpo-metacarpal dislocations.

As in the case of injuries of the shoulder-joint and elbow-joint, familiarity with normal conditions is of the greatest aid in making a diagnosis. The injured wrist should always be compared with the opposite sound one. One should first observe the presence of deformity,

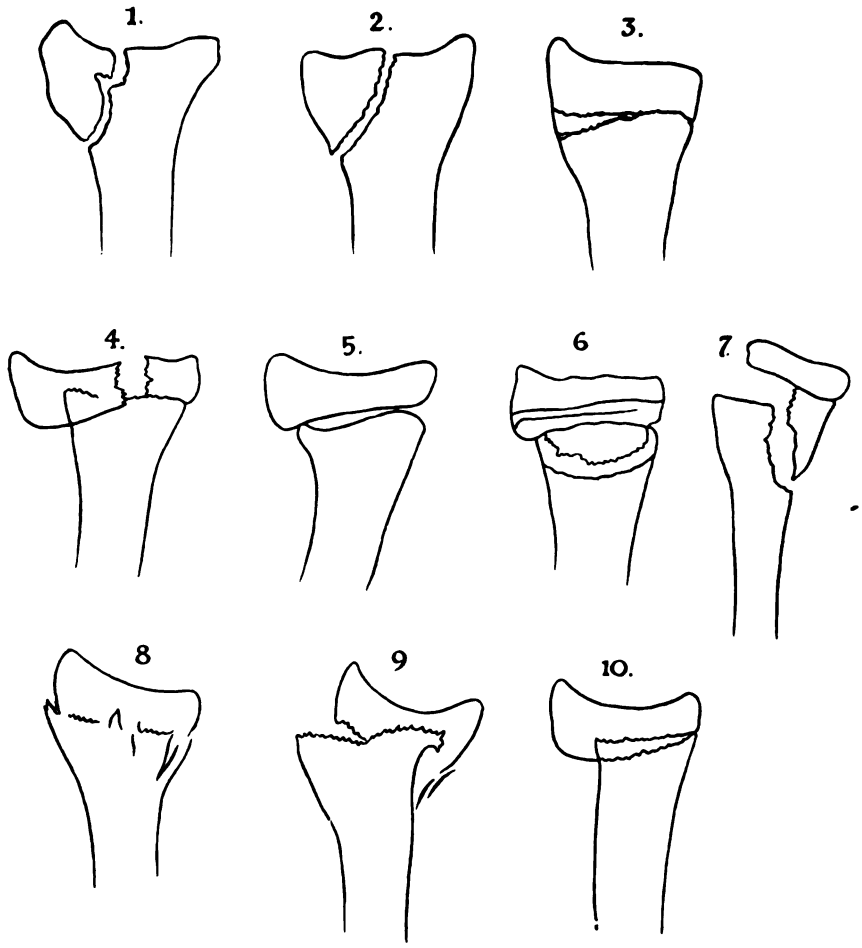


FIG. 364.—OUTLINES OF *X*-RAY PICTURES OF VARIOUS FORMS OF FRACTURE OF THE LOWER END OF THE RADIUS

1, Through base of styloid process; 2, through inner angle of lower end of radius; 3, transverse fracture without displacement; 4, comminution of distal fragments; 5, separation of epiphysis; 6 and 7, separation of epiphysis with chips of diaphysis; 8, impaction of lower into upper fragments; 9, typical Colles' (lateral view); 10, reverse Colles'.

which is often quite marked (Fig. 366). The injured hand is then grasped by the hand of the examiner while upward and downward movements are imparted to the lower end of the radius and ulna to determine abnormal mobility and crepitus. A second and very use-

ful method is to grasp the lower end of the forearm with the two hands of the examiner as shown in Fig. 368. In many of the injuries, especially of the carpal bones, an *x*-ray picture will be found to be indispensable.

(*a*) *Fractures of the Lower End of the Radius.—Colles' Fracture.*—Our knowledge of this most common form of fracture has been greatly increased through the use of the *x*-rays. The various forms of fracture are shown in Fig. 364.

1. Fracture through the base of the styloid process. This is an oblique intraarticular fracture. It is rare and not accompanied by any deformity.

2. Fracture through the inner angle. This is similar to class 1. It is accompanied only by slight enlargement of the wrist. It is easily reduced.

3. Transverse fracture at or above the epiphyseal line (in adults without displacement). It is associated with practically no deformity. As a rule, crepitus can be elicited. In 66 per cent. of the cases there is fracture of the ulnar styloid. In this variety it is important to take a lateral and an anteroposterior view, in order to determine the amount of posterior displacement.

FIG. 365.—DEFORMITY FOLLOWING FRACTURE AT THE LOWER END OF THE RADIUS.

This is the exterior of the same case as is shown in *x*-ray of Fig. 367. Note the displacement of the hand and lower end of the radius toward the radial side of the arm, causing the styloid process of the ulna to become abnormally prominent.

4. Comminuted Colles' fracture. This differs from the typical Colles' fracture only in the fact that the distal fragment is broken into two or more pieces. The classic deformity of a Colles' fracture is always present. There may be impaction of the fragments. If this is present, it should be broken up. Perfect reduction is always difficult, frequently impossible. There is usually some deformity in spite of efforts at perfect reduction.

The styloid process of the ulna is also often broken and inverted. Comminuted fractures constitute about one-third of the cases. Reduction is difficult, and should be done with the aid of an anesthetic and controlled after a few days by a second *x*-ray picture.

5. Separation of the lower epiphysis of the radius. The lower epiphysis unites with the shaft about the twentieth year. The injury is a quite common one, but often overlooked. The displacement is backward, but the fragments remain in contact. The swelling is most marked upon the palmar side of the wrist, instead of upon the extensor surface, as in an ordinary Colles' fracture. There is usually no lateral deformity. The fracture can seldom be recognized without a lateral *x*-ray picture.

6. Separation of the epiphysis with a chip broken from the diaphysis. This is a variety of epiphyseal separation and differs but little from it.

FIG. 366.—VIEW FROM RADIAL SIDE OF A TYPICAL SILVER-FORK DEFORMITY FOLLOWING COLLES' FRACTURE. (See text.)

7. Impaction of the lower fragment into the shaft of the radius. There is always deformity, especially posteriorly, *i. e.*, dorsal and slight radial displacement.

8. Typical Colles' fracture. The characteristics of this class are referred to later under the head of diagnosis.

9. Stellate fracture of the lower end of the radius with longitudinal fissures extending into the shaft. There is little deformity and no impaction.

10. Reversed Colles' fracture. This is the variety to whose deformity Roberts has given the name *gardener's spade.* The ulnar styloid is usually broken.

Many of these are associated with no deformity and show the necessity of routine skiagraphic examinations, not only for the purpose of diagnosis, but for that of treatment as well. The fact that impacted fractures are shown by *x*-ray examinations to be quite frequent, is not as well recognized by the profession as it deserves to be. It is of the utmost

displacement of the lower fragment either to the radial side or posteriorly or both. In epiphyseal separation there is usually less deformity than in the typical form. The most marked symptoms of a Colles' fracture are the prominence over the back of the wrist and the change in outline of the ulnar side of the wrist (Fig. 365). The former is due to the upward displacement of the lower fragment and the latter to the displacement of the lower fragment with the hand toward the radial side of the fore-

FIG. 368.—METHOD OF EXAMINATION FOR FRACTURES OF THE LOWER END OF THE RADIUS.

In the examination of the left forearm the wrist is grasped by the left hand of the examiner close to the point of fracture, while the right arm grasps the bone just above the suspected point of fracture. In the examination of the right arm this order should be reversed.

arm. Crepitus and abnormal mobility can often be obtained by grasping the wrist in one of the ways described above.

If great swelling exists or there is little displacement, and also in children, such an injury must be suspected if there is inability to use the wrist and well-localized pain referred on pressure to the lower end of the radius.

(*b*) and (*c*) Fractures of the styloid process of the ulna alone and of both bones near the wrist are quite uncommon. The former can be recognized by the abnormal mobility of the styloid process. In fractures of both bones the diagnosis is made from the

presence of abnormal mobility, and crepitus at the lower ends of both bones.

(*d*) *Fractures and Dislocations of the Carpal Bones.*—The recognition of these injuries is of great importance, since many cases of sprains or contusions of the wrist are in reality fractures or dislocations of the carpal bones. The large majority of these are either simple fractures of the scaphoid or anterior dislocations of the semilunar bone. The two injuries are frequently combined, and in such cases (Codman and Chase[1]) the proximal fragment of the scaphoid is usually dislocated

FIG. 369.—ONE OF THE METHODS OF EXAMINATION FOR FRACTURE OF THE LOWER END OF THE RADIUS.

In the case of the right radius, the patient's hand is grasped by the right hand of the examiner as though shaking hands. The index-finger of the examiner's right hand is placed below the lower end of the radius, while the fingers of the examiner's other hand are placed on the dorsal side of the same bone By a rocking or to-and-fro movement a false point of motion can be readily detected.

forward with the semilunar bone. Simple fracture of the scaphoid gives a definite clinical picture, and may be recognized, even without the *x*-ray, by the association of the following symptoms: viz., (*a*) The history of a fall on the extended hand; (*b*) localized swelling in the radial half of the wrist-joint; (*c*) acute tenderness in the "anatomic snuff-box" when the hand is adducted; (*d*) limitation of extension by muscular spasm, the overcoming of which causes unbearable pain.

[1] "Annals of Surgery," May, 1905.

Anterior dislocation of the semilunar bone should be recognized clinically, even without the *x*-ray, by the association of the following symptoms: viz., (*a*) The history of an injury of considerable violence to the extended or twisted wrist; (*b*) a silver-fork deformity, the posterior prominence of which corresponds with the head of the os magnum, and between which and the lower end of the radius is found a groove representing the position formerly occupied by the now anteriorly dislocated semilunar; (*c*) a tumor under the flexor tendons of the wrist just anterior to the lower end of the radius; (*d*) a shortened appearance of the palm as compared with the other hand; (*e*) stiffness of the partially flexed fingers, motion of which, either active or passive, is painful; (*f*) the persistence of the normal relation of the styloid processes of the ulna and radius and the existence of shortening of the distance from the radial styloid to the base of the first metacarpal.

Fig. 370.—Fracture of Proximal Phalanx of Thumb.

(*e*) and (*f*) *Dislocations of the Wrist and Carpo-metacarpal Dislocations.*—Dislocation of the wrist is usually compound, but is uncommon. It may occur in a backward or forwrad direction. The former resembles a Colles' fracture, but differs from it by the fact that the prominence on the front of the wrist extends further down, even to the thumb, and ends more abruptly in dislocation than in fracture. The dorsal prominence is also more sharply outlined at its upper border in a fracture. In the forward variety there is a marked depression on the back of the wrist, at the upper border of which is seen the sharp outline of the lower ends of the radius and ulna. There is a rounded prominence on the front of the wrist formed by the displaced carpus. The hand appears to be shortened at the expense of the wrist.

Dislocation backward of the metacarpal bone of the thumb is the most frequent and is oftenest incomplete. The posterior edge of the base of the metacarpal bone can be seen and felt in the depression known on the back of the thumb between the two long extensors. In the complete form this dorsal prominence is more marked. Dislocations of the other metacarpal bones alone or of all five simultaneously are

FIG 371.—BENNET'S FRACTURE OF METACARPAL BONE OF THUMB (Dr. E. W. Ryerson's case).

quite rare, and the reader is referred to the special text-books on fractures for their recognition.

Injuries of the Metacarpal Bones and Phalanges.—Fractures of the metacarpal bones and phalanges are far more common than was thought to be the case before the use of the *x*-ray. Many are not diagnosed, owing to the absence of displacement, unless a skiagraph is taken of every severe sprain or contusion of the hand. The deformity in metacarpal fracture is usually quite slight, except in those

close to the metacarpo-phalangeal joint. In the latter class there is often a distinct depression, best seen when the joint is flexed, resem-

FIG. 372.—FRACTURE OF FIRST, SECOND, AND THIRD METACARPAL BONES (Dr. John Ridlon's case).

bling a dislocation at this joint. At times the displacement of fragments in the shaft can readily be palpated. The deformity is often obscured by the great amount of swelling. Abnormal mobility and crepitus can be elicited by alternately flexing and extending the fingers, while the suspected bone is grasped between the index-fingers and thumbs of both hands of the examiner, the latter being placed on the dorsum and volar surfaces of the hand.

FIG. 373.—FRACTURE OF MIDDLE PHALANX OF RING-FINGER WITH MALUNION OF FRAGMENTS.

Fractures of the phalanges are usually due to crushing forces. The proximal phalanx is most frequently involved. The diagnosis can be readily made by inspection of the wound in compound fractures. In the simple variety crepitus and abnormal mobility are easily elicited by grasping the phalanx with the fingers of the examiner and moving it to and fro. In those close to a joint the diagnosis is more difficult, and often ne-

cessitates the use of the *x*-ray, especially in children, in whom epiphyseal separation (Fig. 345) is not infrequent.

Dislocations of the proximal phalanx of the thumb are the most frequent of all, in the hand. The backward form is the most common one. The proximal end of the phalanx is to be seen and felt on the

FIG. 374.—X-RAY OF A NORMAL HAND AND WRIST-JOINT.

The radius and ulna have been outlined in white; the carpal bones in black. U, Ulna; R, radius; P, pisiform; CF, cuneiform; SL, semilunar; SP, scaphoid; TM, trapezium; T, trapezoid; OM, os magnum; U, unciform.

back of the thumb, lying upon the metacarpal bone, the thumb being adducted. The head of the metacarpal bone can be seen and felt projecting on the front of the thumb. In forward dislocations the deformity is the opposite of the above.

Dislocations at the metacarpo-phalangeal joints occur most fre-

quently in the thumb and index-finger and in a backward direction. There is a prominence on the back of the hand, due to the base of the phalanx and one in the palm, due to the head of the displaced metacarpal bone. The finger may be extended or slightly flexed. The forforward form is less frequent and the deformity is the reverse of that of the backward variety.

Dislocations of the middle and distal phalanges usually occur in a backward direction and are not difficult to recognize from the deformity. They are frequently compound.

FIG. 375.—FRACTURE OF METACARPAL BONE OF LITTLE FINGER.

Fractures of the Pelvis.—Fractures of the pelvis may be divided into:

1. *Those which involve the pelvic girdle as a whole:*

(*a*) Separation of the symphysis pubis.

(*b*) Fracture of the horizontal and ascending rami of the pubes.

(*c*) Vertical (single or double) fractures of the lateral portions, *e. g.*, the ilium passing through the acetabulum.

2. *Those which involve individual bones:*

(*a*) Fractures of the expanded upper portion of the ilium.

(*b*) Fractures of the rim of the acetabulum.

(*c*) Fractures of the ischium, sacrum and coccyx.

Of the above, the commonest are those in which the rami of the pubis or ischium or the alæ of the ilium are broken. The remaining ones are very rare. Fractures of the rim of the acetabulum resemble dislocation of the hip so closely that they will be considered under the injuries of the hip. For diagnostic purposes, fractures of the pelvis are best divided into (*a*) *those complicated by visceral injury*, and (*b*) *those not accompanied by such a lesion.* The possibility of a fracture of the pelvis with or without visceral complications must always be

thought of in examining a patient who has been subjected to a crushing force, such as being run over, caught between buffers, etc. The diagnosis of fractures of the crest of the ilium and of those involving the ala or expanded upper portion of the ilium is, as a rule, not difficult. Crepitus is seldom present and but little force should be employed in efforts to elicit it. *Chief reliance must be placed upon localized pain and abnormal mobility.* These are best elicited by a systematic examination of the entire crest of the ilium, placing a hand on each side of the pelvis, while pressure is gently exerted upon the underlying bone. In many cases it is possible by this manipula-

FIG. 376.—ANTERO-POSTERIOR AND LATERAL *x*-RAY VIEW OF FRACTURE OF THE SHAFT OF THE SECOND PHALANX OF THE MIDDLE FINGER, IN A GIRL OF EIGHT.

Exterior picture of this is shown in Fig. 377.

tion to detect either displaced fragments or abnormal mobility. The latter sign is more apt to be present than the former. Repeated examinations will often show the pain to be accurately localized to the seat of fracture. In fractures of other portions of the pelvis it is inadvisable to attempt to make a diagnosis by manipulation. Usually there is but little displacement, so that the diagnosis must be made from the accompanying visceral injuries. A rectal examination and an *x*-ray should never be omitted in doubtful cases, as they often enable an exact diagnosis to be made.

The complications of fractures of the pelvis are, in the order of

their frequency: (1) Rupture of the urethra; (2) rupture of the bladder; (3) rupture of one of the other abdominal viscera (kidney, spleen, liver, bowel, etc.); (4) rupture of the external iliac artery or vein.

A diagnosis of such visceral injuries is only of value for treatment by operation if made during the first twelve to twenty-four hours after injury, and if the patients are unable to urinate or blood escapes from the urethra they should be most thoroughly examined with these lesions in mind.

The principal diagnostic points of these are as follows:

1. *Rupture of the Urethra.*—(*a*) Retention of urine. If the patient is able to urinate, the act is only accomplished with great difficulty

FIG. 377.—COMPOUND FRACTURE OF PHALANGES.
This is the exterior view of the case of which the *x*-ray is shown in Fig. 376. (See text.)

and pain, the urine is scanty and accompanied by considerable amounts of clotted and liquid, bright-colored blood. (*b*) Pain over the perineum and end of the penis. (*c*) Swelling and evidences of subcutaneous hemorrhage of the perineum, scrotum, and penis. (*d*) Blood escapes from the urethra, and when the catheter is inserted bloody urine in small quantity is withdrawn.

2. *Rupture of the Bladder.*—In extraperitoneal rupture, an area of dullness appears (Fig. 379) above the pubes and there is a feeling of fullness around the bladder when a rectal examination is made. There is retention of urine or an incontinence of retention exists. Small amounts of bloody urine constantly escape from the external meatus.

If a catheter is inserted into the bladder, a small quantity of bloody urine is obtained. If, as in one case of the author's, a fracture of the pelvis is complicated both by an extraperitoneal rupture of the bladder and a rupture of the urethra, a diagnosis of the presence of both conditions is seldom possible. In the majority of cases the bladder injury which accompanies fractures of the pelvis is in the form of an extraperitoneal rupture. Those in which the tear is in that portion

FIG. 378.—TYPICAL LOCATIONS OF LINES OF FRACTURE IN FRACTURES OF THE PELVIS.

Note the line of fracture passing through the horizontal ramus of the pubis, and a second at the junction of the descending ramus of the pubis and ascending ramus of the ischium. The posterior fracture lines pass through the ilium in a Y manner, terminating in the greater sciatic notch.

of the viscus covered by peritoneum are much less frequent. The diagnosis of such intraperitoneal ruptures of the bladder has already been referred to (page 264). The symptoms are those of a septic peritonitis, but are slower and more insidious in their appearance than in the case of a ruptured intestine, etc. Injuries of the other abdominal viscera must always be thought of in connection with fractures of the pelvis. Their symptoms and diagnosis do not differ from those previously given.

The Diagnosis of Injuries of the Hip.—The possibility of the following lesions must be borne in mind in adults:

1. Fracture of the neck of the femur.
2. Dislocation of the hip.
3. Fracture of the head of the femur or rim of the acetabulum.
4. Fracture of and through the greater or lesser trochanter.
5. Contusion of the hip.
6. Dislocation of the hip accompanied by fracture of the acetabulum, greater trochanter, or neck of the femur.

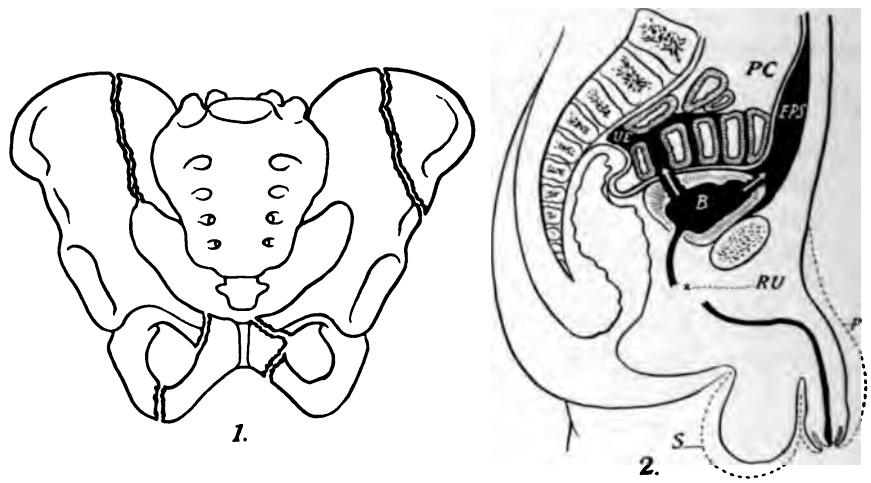


FIG. 379.—VARIETIES OF FRACTURES OF THE PELVIS AND MOST FREQUENT COMPLICATIONS.

1, Shows the most frequent lines of fracture of the pelvis (see text); 2, shows the three most frequent complications of fractures of the pelvis. *RU*, Rupture of urethra associated with extravasation of urine into the scrotum (*S*) and penis (*p*); *B*, bladder. The arrow upon the anterior wall indicates an extraperitoneal rupture of the bladder with extravasation of urine into the extraperitoneal cellular tissue around the bladder and between the peritoneum and anterior abdominal wall (*EPS*). The arrow situated upon the posterior wall and the fundus of the bladder indicates the escape of urine through an intraperitoneal tear into the free peritoneal cavity. The black area (*UE*) indicates the urine escaping between the coils of intestine into the general peritoneal cavity (*PC*).

In children and young adults the lesions to be especially considered are: (*a*) Fracture of the neck of the femur, (*b*) epiphyseal separation of the head. The relation of coxa vara to these injuries is considered on page 575.

The examination when conducted in a systematic manner will enable a diagnosis to be made in the majority of cases without the use of an *x*-ray. The latter should, however, be employed as a routine method whenever possible. Satisfactory skiagraphs of the hip, especially in adults, are very difficult to obtain unless the operator has had considerable experience and is provided with an excellent tube or uses the diaphragm apparatus of Albers-Shönberg referred to under Renal Calculi on page 426.

The chief points to be determined are: (*a*) The position of the limb. (*b*) The amount of shortening as determined by a measurement of the limb in the manner indicated in Fig. 380, viz., from the lower border of the inner malleolus (when the limb is adducted) through the middle of the patella to the anterior superior spine of the ilium. (*c*) The relation of the upper border of the trochanter to the Roser-Nélaton line (Fig. 382). (*d*) A fourth step is to determine the measure-

FIG. 380.—MEASUREMENT OF LENGTH OF LIMB TO BE EMPLOYED IN CASES OF DISLOCATION OF THE HEAD OF THE FEMUR OR FRACTURE OF ITS NECK.

One end of the steel tape-measure is laid upon the anterior superior spine of the ilium, which has been previously outlined with ink or a blue pencil, while the other hand holds the tape-measure immediately below the inner malleolus. The tape passes through the middle of the patella. Both limbs should be placed flat upon the table at an equal distance from the median line, *i. e.*, adducted. For photographic purposes the limb is shown placed across the opposite one.

ments of the Bryant triangle (Fig. 381). This is done by dropping a steel tape from the anterior superior spine of the ilium to the table or bed upon which the patient rests, and marking the position of the lower border of the tape upon the patient's gluteal region in ink. A thin wooden rod held against the side answers the purpose even better. The distance of the upper border of the greater trochanter from this vertical line is now measured and compared with a similar measurement taken

on the opposite side. In the normal adult this distance is 2½ inches. (*e*) Gentle manipulation of the limb to determine the presence or absence of crepitus, abnormal mobility, or fixation, etc.

In doubtful cases it is advisable to administer an anesthetic, owing to the fact that the muscular rigidity disappears; otherwise it might render a diagnosis very difficult or impossible.

The principal diagnostic features of the above-named lesions of the hip are:

1. *Fractures of the Neck of the Femur.*—These may take place either at the point of junction of the head or at the base of the neck

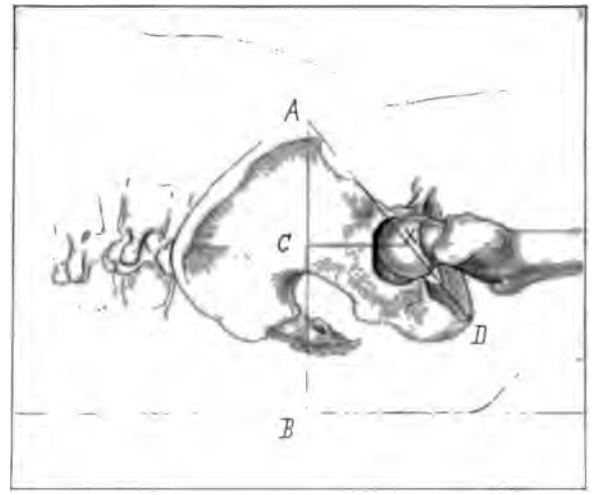


FIG. 381.—BRYANT'S TRIANGLE (Scudder).

A C X, Bryant's triangle. Distance (X C) from top of trochanter to perpendicular (A B) dropped from anterior spine to horizontal table is Bryant's measurement. After fracture this measurement may be less than normal.

where it joins the shaft. It is of little importance, from the standpoint of either diagnosis or treatment, to determine whether the fracture is situated within or without the capsule, *i. e.*, intracapsular or extracapsular.

It is of far more value to ascertain whether the fracture is impacted or not. Loss of function of the limb is, as a rule, quite marked. The patient is unable to walk upon the limb or to move it without experiencing great pain in the hip, and then only to a very limited extent. There is often pain on pressure over the trochanter or neck of the bone. The position is quite characteristic (Fig. 384). The limb is usually everted so that the outer border of the foot rests upon the bed. Quite

rarely the limb is inverted, this being more marked after a few days. Measurement of the limb must always be carried out with both limbs in the same position, if possible brought as near as may be to the median line of the body with the toes pointing upward. The three standard modes of measurement are: (*a*) From the lower border of the inner malleolus to the anterior superior spine of the ilium (Fig. 380). (*b*) Bryant's method. A line is dropped from the anterior superior spine to the table or bed in a perpendicular manner as described on page 381. The distance from the upper border of the trochanter to this line is

FIG. 382.—METHOD OF DETERMINING THE RELATION OF THE TROCHANTER TO THE ROSER-NÉLATON LINE.

The patient is laid upon the side of the body opposite to the one to be examined, the steel tape is stretched from the anterior superior spine of the ilium, *ASSP*, to the tuberosity of the ischium. These two points are fixed by the index-fingers of the two hands, preferably those of an assistant, while the examiner marks the lower level of the tape as it crosses the upper border of the trochanter. Under normal conditions the tape should pass exactly along the upper border of the trochanter.

less on the side of the injury than upon the opposite side. (*c*) The Roser-Nélaton line (Fig. 382). These measurements should always be made upon the bare skin, the various points having been previously marked.

In fracture of the neck of the femur the above measurements will show a shortening which varies from a small fraction of an inch to two or three inches. It may be present at its maximum, just after the accident, or absent at first and appear gradually or suddenly after a few hours to days. It must not be forgotten that a normal difference of ½ to 1 inch may exist in the length of the limbs. Crepitus is present in unimpacted but is absent in impacted fractures.

Only the most gentle manipulation is permissible to elicit crepitus, since rough handling may readily do great damage in breaking up an impaction.

Palpation of the neck of the femur in the manner shown in Fig. 386, while an assistant rotates the limb very gently, will often enable one to detect abnormal mobility, thickening or tenderness about the neck of the bone. The history of the case will show that the majority of patients fell upon the region of the greater trochanter, rarely upon the more distant portions of the limb. Fracture of the neck of the femur in young people is considered separately.

FIG. 383.—LOCATION OF MOST FREQUENT FRACTURE OF UPPER END OF FEMUR.

1, Epiphyseal separation; 2, subcapitalis, at junction of head and neck; 3, junction of neck and shaft; 4, of great trochanter; 5, subtrochanteric through upper third of shaft.

2. *Dislocation of the Hip.*—This may occur chiefly in a forward or backward direction. The classification which is almost universally accepted is as follows: (1) Backward dislocations: (*a*) Dorsal (including the iliac and ischiadic); (*b*) everted dorsal (including the supraspinous). (2) Downward and inward dislocations: (*a*) Obturator; (*b*) perineal. (3) Forward and upward dislocations, suprapubic (ileopectineal, pubic, and central or intrapelvic). (4) Upward dislocations (supracotyloid or subspinous). (5) Downward dislocations (on the tuberosity of the ischium). Of the posterior or backward variety there are two forms: (*a*) the iliac, the head resting upon the dorsum of the ilium, and (*b*) the ischiadic, the head being located in the sciatic notch. Of the anterior or forward variety there are also two forms: (*a*) the obturator or thyroid, the head lying over the obturator foramen, and (*b*) the pubic, the head resting upon the pubic ramus.

The majority of hip dislocations are dorsal (55 per cent.), the next most frequent are the ischiadic (20 to 25 per cent.), then the obturator (15 per cent.), and the pubic (5 per cent.).

The signs of the two forms of backward dislocation are practically the same, those of the dorsal being more marked than is the case with

the ischiadic variety. The position of the limb is one of moderate adduction and flexion, marked inversion, and more or less shortening, the toes of the injured limb resting upon the sound foot (Fig. 387). Measurement of the limb shows that the trochanter lies above the Roser-Nélaton line. It is almost impossible to bring the two limbs into a sufficiently symmetrical position to enable an accurate measurement

FIG. 384.—EVERSION OF LOWER EXTREMITY IN A CASE OF RECENT FRACTURE OF THE NECK OF THE FEMUR.

The arrow points to the markedly everted limb. 1 and 2, Anterior superior spines of the ilium; 3 and 4, placed on center of patellæ; note how the patella on the fractured side points outward; 5 and 6, marks placed on lower border of internal malleoli. The measurement of the limb for shortening should be made as shown in Fig. 382, from 2 to 6 on the fractured side, and 1 to 5 on the normal side, passing through the middle of the patellæ. The characteristic shortening of the limb can be observed by comparing the points 5 and 6, taking into consideration at the same time the elevation of the pelvis on the side of the injury.

of their length to be made, but this is rarely necessary to make a diagnosis.

The head of the bone can be indistinctly felt through the gluteal muscles, especially when attempts are made to rotate the limb.

In forward or anterior dislocations of the hip, the limb is slightly flexed, abducted, and rotated outward. There is apparent lengthening of the limb, but careful measurement will show that this is not real.

In the obturator form, the head of the bone can be indistinctly felt toward the obturator foramen. In the pubic form the limb is consider-

FIG. 385.—X-RAY OF A FRACTURE OF THE NECK OF THE FEMUR, AT THE JUNCTION OF THE HEAD AND NECK, WITH UPWARD DISPLACEMENT OF THE SHAFT OF THE FEMUR.

On the opposite side note the outlines of the normal femur and hip-joint. This *x*-ray was kindly loaned to the author by Dr. Le Moyne Wills.

FIG. 386.—METHOD OF EXAMINATION OF THE LOWER EXTREMITY FOR ABNORMAL MOTION AT NECK OF FEMUR.

For photographic purposes it was necessary to have the examiner stand upon the left side of the patient. In practice in examining the right lower extremity the left hand should grasp the trochanter, the fingers placed upon the back of the latter, and the thumb upon its anterior surface. The right hand should be placed across the front of the ankle-joint. In examining the left limb, the order should be reversed the right hand being placed over the trochanter, and the left over the ankle.

ably more abducted and everted than in the thyroid variety. The head of the femur can also be more distinctly felt in the groin.

The remaining varieties of hip dislocation are rare. The central dislocation is an exception to this, but is in reality a fracture. The head of the femur is forced through the acetabulum into the pelvis. The injury was formerly considered quite rare, but the use of the *x*-ray has shown this to be incorrect. Twenty-eight cases have been collected to 1907 by Wolff.[1] The limb is everted. The deformity can be reduced, but gradually recurs. There is a decrease in the distance between the anterior superior iliac spine and the trochanter. The head of the femur can be felt by rectal examination. The most exact method of diagnosis is the *x*-ray.

FIG. 387.—DISLOCATION OF HIP, DORSUM ILII VARIETY (Macdonald).

3. ***Fracture of the Head of the Femur or Rim of the Acetabulum.***—The former is so rare and has so few characteristic signs that it may be left out of consideration in the differentiation of injuries of the hip.

Fractures of the acetabulum are also infrequent. In the majority of such cases the posterior rim of the acetabulum is broken off and the accompanying dislocation is backward. Fracture of the rim of the acetabulum may occur as a complication of backward dislocations of the hip, from which it can only be distinguished, without the use of the *x*-ray, by the fact that the dislocation can be reduced without difficulty, possibly with crepitus, but tends to recur. Fractures of the acetabulum occur fairly often as isolated injuries especially of the posterior rim.

It can be distinguished from fracture of the neck of the femur by the straightness and lack of eversion of the limb, and from *backward dislocation* of the hip, by the position of the limb, viz., adduction, inward rotation, and slight flexion.

4. ***Fracture of or through the great trochanter.*** Both of these are very rare. In the former the diagnosis can only be made without a skiagraph

[1] "Beiträge zur klinischen Chirurgie," vol. lii.

by the independent mobility of the trochanter. In the fracture through the great trochanter, the *pertrochanteric fracture of Kocher*, the differentiation from ordinary fractures of the neck is impossible unless a prominent angle is distinctly visible anteriorly, which is formed by the two fragments. The eversion and shortening of the limb are the same as in fracture of the neck.

5. *Contusion of the Hip.*—If the case has been systematically examined as to the history of the accident, the posture and loss of function of the limb, the shortening and fixation, the diagnosis from a simple contusion ought not to present any difficulties. Contusion of the hip

FIG. 388.—WASH DRAWING MADE FROM SKIAGRAPH OF CASE OF OBTURATOR DISLOCATION OF THE HIP COMPLICATED BY FRACTURE OF THE NECK OF THE FEMUR (INDICATED BY ARROW).

may occur at any age. It usually follows a fall upon the trochanter, and there are often evidences of a contusion of the soft parts around it. The limb is straight, the head of the bone cannot be felt in an abnormal place, there is no shortening, and the trochanter lies in the Roser-Nélaton line and rotates in the normal manner. There may be localized pain and some limitation of motion. If there is any doubt the administration of an anesthetic is of great aid. The same may be said for the *x*-ray.

6. *Dislocation of the hip accompanied by fracture of the upper end of the femur or rim of the acetabulum.*

Fracture of the neck of the femur has been observed accompanying an obturator dislocation. It is important to know of such a complication, since a reduction of the deformity in a fracture accompanied by such a dislocation may be impossible without operative interference (see Fig. 388).

Injuries of the Neck of the Femur in Early Life.—Acquired traumatic dislocations of the hip are infrequent in early life, and until recent years it was thought that fractures of the neck of the femur were equally rare.

FIG. 389.—SKIAGRAPH OF CASE OF COXA VARA FOLLOWING FRACTURE OF NECK OF FEMUR CLOSE TO SHAFT IN EIGHT-YEAR-OLD CHILD (H. A. Wilson).

The arrow points to the line of fracture. T, Trochanteric epiphysis; E, epiphysis forming head of normal side; T, trochanteric epiphysis on normal side.

Coxa Vara Traumatica.—This name was first given by Sprengel[1] in 1898 to a condition following injuries of the neck of the femur in children and young adults. According to Sprengel and others, the resultant deformity, which consists of a bending downward and backward of the neck, is due to an epiphyseal separation which may be complete or incomplete.

Whitman[2] is of the opinion that the injury is a true fracture of the neck and only rarely a separation of the neck from the head at their junction (Fig. 389). In the majority of cases the lesion is undoubtedly one of epiphyseal separation. In both epiphyseal separations and

[1] "Archiv für klinische Chirurgie," Bd. lvii. [2] "Medical Record," March 10, 1904.

fractures of the neck the condition may follow even a slight trauma and result in the deformity known as coxa vara (page 743).

In children fracture of the neck can be distinguished clinically and with the *x*-ray from epiphyseal separation, according to Whitman, as follows:

In fracture of the neck there is more shortening, less outward rotation, and the trochanter is more prominent. Motion at the hip-joint is practically free, except in abduction, which is particularly restricted when the limb is flexed.

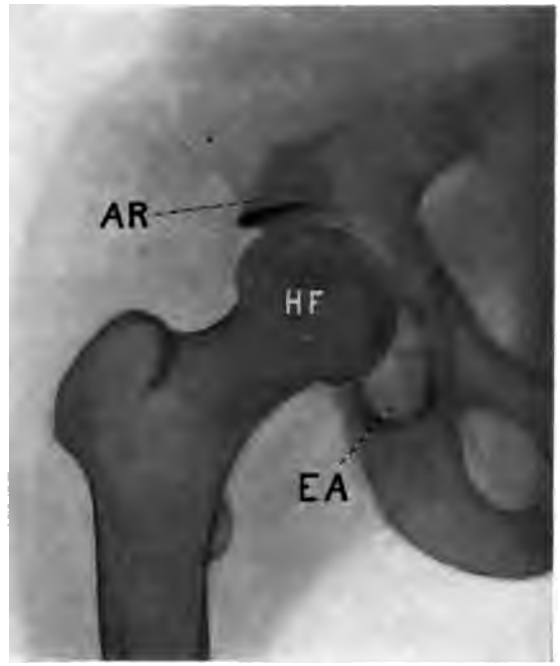


FIG. 390.—X-RAY OF FRACTURE OF RIM OF ACETABULUM.

AR, Fragment of rim of acetabulum, which has been displaced upward and backward; HF, head of femur which has been allowed to be displaced through the absence of the acetabular rim, thus causing a backward and upward dislocation of the hip-joint; EA, empty acetabulum.

In epiphyseal separation the shortening is less, the outward rotation greater. Frequently there is a swelling to be felt over Scarpa's triangle over the position of the head. The trochanter is not as prominent, but motions at the hip-joint are always more restricted, due to dislocation of the head and to the reflex muscle spasm resulting from the traumatic synovitis.

The cases are often seen months to years after the accident, when the resultant coxa vara is the most prominent sign. At such a period it is impossible to differentiate a traumatic coxa vara from a true coxa vara.

Fractures of the Femur.—The diagnosis of these fractures usually presents no difficulties. Their recognition is easier when the fracture is a complete one and the periosteum has been torn. In such patients the usual signs of fractures, viz., abnormal mobility, deformity, crepitus, loss of function, and pain are quite marked.

If the fracture is incomplete or the periosteum has not been torn, as not infrequently occurs in children, especially in those suffering from scurvy or rachitis, the diagnosis is far more difficult. This is due to the fact that

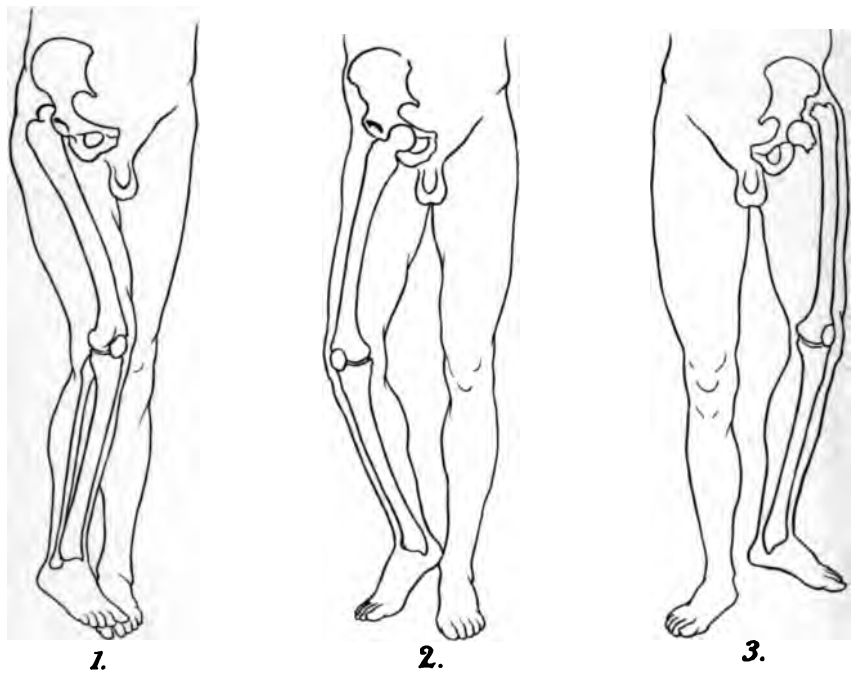


FIG. 391.—MOST FREQUENT CONDITIONS TO BE CONSIDERED IN DIFFERENTIAL DIAGNOSIS OF INJURIES OF THE HIP-JOINT.

1, Backward and upward dislocation of the head of femur; 2, forward dislocation of head of femur; 3, fracture of neck of femur.

there is but little deformity and the diagnosis depends chiefly upon the elicitation of crepitus and abnormal mobility combined with localized pain and loss of function.

Fractures of the shaft are divided into those (*a*) of the upper, (*b*) of the middle, and (*c*) of the lower third. In fractures of the upper third the line of fracture is most oblique, the upper fragment being displaced upward and forward and the lower one upward and inward (Fig. 393), resulting in a greater degree of shortening than is present in fracture of the other two-thirds.

In fractures of the middle third the line of fracture is either oblique or spiral in direction. Even in healthy children the periosteum often remains untorn in fractures at this level. Both fragments are usually displaced outward, forming an angle, or there is considerable overlapping of the fragments.

In fractures of the lower third the line of fracture is oftener transverse and the upper fragment overrides the lower, there being but little tendency to outward displacement.

The diagnosis of fractures of the shaft depends to a great extent upon the recognition of the deformity and shortening which result from the displacement of fragments. This is often so marked and visible as to require but little manipulation.

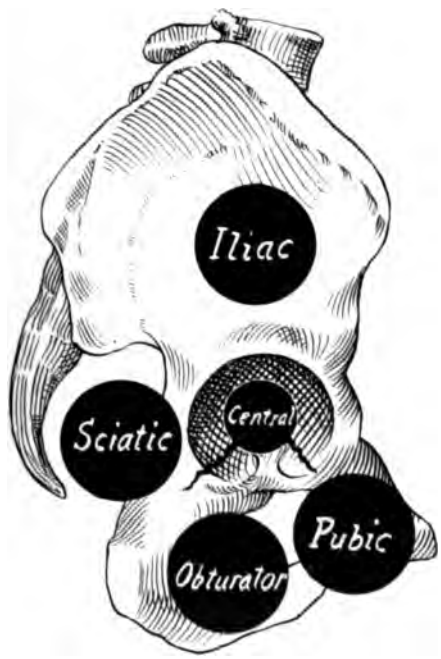


FIG. 392.—LOCATION OF HEAD IN VARIOUS FORMS OF DISLOCATION OF HIP.

The degree of shortening can be determined by measurement of the limbs from the anterior superior spine of the ilium to the lower border of the inner malleolus, and comparison with that of the opposite limb. Both limbs should form the same angle with the pelvis when the measurements are made and should be brought as close to the median line of the body as possible.

Abnormal mobility and crepitus are most marked in fractures of the upper and middle thirds, especially if complete, and can be best elicited by grasping the limb in the manner shown in Fig. 386.

The projecting ends of the upper and lower fragments can often be felt beneath the skin in simple fractures or projecting through it in compound fractures. In fractures of the lower third the diagnosis is more difficult, on account of the accompanying effusion into the knee-joint and the slighter degree of displacement of fragments. There is usually, however, marked loss of function, swelling, and some degree of deformity.

In every case in which the diagnosis of fracture of the lower third of the femur (supracondyloid) has been made an examination of the limb

distal to the knee should be made. This should include (*a*) the palpation of the superficial arteries, like the dorsalis pedis and posterior tibial, for loss of pulsation as the result of injury of the popliteal artery, and (*b*) the changes in color of the limb, swelling, etc., which might result from compression and thrombosis of the popliteal vein (Fig. 311).

Fractures of the Lower End of the Femur.—These greatly resemble those of the lower end of the humerus. They are: (*a*) Intercondyloid; (*b*) fractures of either condyle; and (*c*) separation of the lower epiphysis.

In the intercondyloid variety the line of fracture is either T- or Y-shaped, is very apt to be compound and associated with injury of the popliteal vessels. The diagnosis is made from the independent mobility of the two condyles on each other, when they are moved backward and forward, and by the pain, when they are pressed together. Effusion into the knee-joint is constant and often obscures the recognition of the fracture. Separation of either condyle is not accompanied by any shortening. It is quite rare and is usually overlooked because there is but little displacement. Separation of the lower epiphysis of the femur is next in order of frequency to epiphyseal separation of the upper end of the humerus. The epiphysis is usually displaced forward and the shaft pulled backward by the gastrocnemius muscle. The latter displacement may in some cases endanger the popliteal vessels, as in supracondyloid fracture (Fig. 311). The epiphysis is often rotated 90 degrees (Fig. 396), so that its joint surface faces the patella.

FIG. 393.—DEFORMITY FOLLOWING FRACTURE OF THE FEMUR.

The diagnosis of epiphyseal separation can be made from (*a*) the presence of abnormal mobility in a young person, just above the knee-joint; (*b*) the palpation of the two fragments, the lower in front of the upper, and (*c*) the elicitation of a soft cartilaginous crepitus. One should never neglect to search for absence of pulsation of the superficial arteries below the point of fracture and note any changes in the color of the limb.

Injuries in the Vicinity of the Knee-joint.—These include:

1. Fractures and epiphyseal separation at the lower end of the femur.

2. (*a*) Fractures or (*b*) dislocation of the patella.
3. Dislocations of the knee (upper end of the tibia).
4. Fractures of the upper end of the (*a*) tibia and (*b*) fibula.
5. Sprain or other injuries of the knee-joint proper and of its ligaments.

In every case of injury in the vicinity of the knee one must exclude all of the above named injuries through systematic examination as follows:

(*a*) Inspection. This will often show at once the presence of a deformity, changes in color of the limb due to vessel injury, or the swelling

FIG. 394.—METHOD OF MEASURING THE LENGTH OF THE TWO LIMBS IN A CASE OF FRACTURE OF THE SHAFT OR OF THE NECK OF THE FEMUR.

While the patient is lying upon his back, three points should be marked on each limb, as shown in the illustration, namely, the anterior superior spine of the ilium, the middle of the patella, and the lower border of the inner malleolus. There may be apparent shortening due to the elevation of the pelvis, as shown in the illustration. The method of measurement consists in placing one end of a steel tape-measure on the anterior superior spine, and the other across the line drawn just below the inner malleolus. The tape-measure should pass exactly through the line drawn in a vertical manner through the middle of the patella. In the illustration this latter line has been purposely shown a little to the inner side of the tape-measure. The outward rotation of the limb in fractures of the shaft of the femur is well shown in this patient.

of the knee-joint proper with obliteration of its normal depressions (Fig. 399) on either side of the patella.

(*b*) Palpation and manipulation. This will show: (1) the presence of fluid in the knee-joint by ballotement of the patella (Fig. 521) and measurement of the circumference; (2) palpation of the surface of and position of the patella will show the presence or absence of a fracture or dislocation of this bone; (3) manipulation of the knee as shown in Fig. 397 will reveal the presence of abnormal mobility due to laceration of the lateral liga-

ments; (4) palpation and manipulation of the lower end of the femur and upper end of the bones of the leg will reveal the presence or absence of abnormal relation to each other, as in dislocation of the knee, or of abnormal mobility, deformity, or crepitus, as in fractures or epiphyseal separation.

The methods of examination for ruptured ligamentum patellæ and for injuries of the semilunar cartilages have been previously given.

The principal diagnostic points of the above-named injuries are as follows:

FIG. 395.—METHOD OF EXAMINATION FOR FRACTURE OF SHAFT OF FEMUR

The injured thigh is laid upon the outstretched hand of the examiner, with palm upward, while the opposite hand grasps the middle of the leg. While the hand which is supporting the point of fracture fixes the thigh to some extent, the opposite hand by a motion to and away from the median line of the body enables one to determine the false point of motion. In this illustration the forward bowing of the limb due to slipping of the fragments past each other is well shown, causing considerable shortening of the limb.

1. *Fractures and Epiphyseal Separation of the Lower End of the Femur.*—(See page 579.)

2. (*a*) *Fractures of the Patella.*—There is usually great swelling of the knee, most marked about six to eight hours after the accident. Unless this effusion into the knee is too extensive, it is possible to feel a hiatus or gap in the patella and to move the two fragments independently of each other, by grasping them between the thumb and index-fingers. Crepitus can often be elicited by this manipulation. If the fragments are close together, both of these signs are less marked. The patient is unable to extend the limb, and there is usually great pain in the knee, especially when the fragments are pressed together or the

limb is flexed. For purposes of treatment it is of some importance to know the extent of laceration of the lateral portions of the aponeurosis of the quadriceps extensor. It has been suggested that the extent of the tears the aponeurosis be determined by the power of extending the knee which the patient still possesses. Such a test is apt to be misleading, especially immediately after the injury, when there is much contusion of the soft parts and a large amount of intraarticular effusion. Extensive aponeurotic tears and wide diastasis of the fragments do not prevent almost complete extension of the knee.

FIG. 196. SKIAGRAPH (LATERAL VIEW) OF TRAUMATIC SEPARATION OF LOWER EPIPHYSIS OF FEMUR IN A BOY OF EIGHT.

Observe how the upper fragment projects in the popliteal space, and how the lower fragment is tilted vertically.

2. (*b*) *Dislocations of the Patella.*—These are quite rare, forming about one per cent. of all forms of dislocation. Dislocation may occur outward, inward, or edgewise (vertical). Of these, the outward variety is the most frequent. The knee appears flatter and broader than usual and the intercondyloid notch is quite prominent. The patella can be felt on the outer side of the condyle, and at its upper and lower ends respectively the quadriceps tendon and ligamentum patellæ can be felt as tense bands. The inward and vertical forms are rare and their recognition is similar to that of the outward form.

3. *Dislocations of the Knee.*—These are as rare as those of the patella. This form of dislocation is very rare in children. Dislocations of the knee are divided, according to the direction in which the tibia is displaced, into forward, backward, outward, and inward varieties, and there is a fifth form, or dislocation by rotation. The lateral (outward and inward) varieties are usually associated with more or less rotation. *Dislocation forward* is the most frequent of all and can be readily recognized. The tibia lies in a plane in front of that of the thigh. The outline of the tibia can be seen and felt lying in front of the lower end of the femur, the latter being prominent in the popliteal space. The limb may be fixed or movable in any direction. There may be evidences of injury of the popliteal artery and of the internal popliteal nerve; the former

can be recognized by the loss of pulsation and the latter by the loss of sensation (pages 496 and 497).

In the backward variety the above signs are reversed. The head of the tibia lies behind the condyles of the femur and can be felt in the popliteal space. There is a marked depression below the condyles of the femur in front of the knee. Injury of the popliteal vessels is even more frequent than in the forward variety.

Lateral dislocations are quite rare and their recognition is not difficult, the outer part of the head of the tibia projecting on the outer side

FIG. 397.—METHOD OF DETERMINING ABNORMAL LATERAL MOBILITY OF KNEE-JOINT, DUE TO TEARING OR STRETCHING OF THE LATERAL LIGAMENTS.

The patient while lying down is grasped so that the knee rests upon the palm of the examiner's right hand, if the left limb is to be examined, and vice versâ in the case of the right limb, while the opposite hand grasps the leg at about its middle, the object being to fix the knee more or less with the hand beneath it, while the other hand by to-and-fro motions determines any increase in lateral mobility.

of the joint in the outward and in the opposite manner in the inward variety.

4. *Fractures of the Upper End of the Tibia and Fibula.*—Fractures of the upper end of the tibia usually extend into the knee-joint. The most frequent form is that in which the line of fracture is oblique and results in the separation of either the internal or external condyle from the remainder of the bone (Fig. 401). In addition to the oblique fractures of the condyles, transverse and longitudinal fractures occur, but are comparatively infrequent. A form of compression fracture has also been described by Wagner of Königshütte, in which there is a fracture

of either condyle and more or less marked crushing of the head of the tibia after a fall upon the foot.

The diagnosis of a fracture of the upper end of the tibia is often impossible without the aid of an anesthetic and the *x*-ray. In almost every case the accompanying effusion into the knee-joint is so marked after a few hours as to render an examination very difficult.

In fractures involving one of the condyles abnormal mobility of the knee either in an inward or outward direction will be found when the

FIG. 398.—SKIAGRAPH OF FRACTURE OF PATELLA THREE YEARS AFTER INJURY.
Note the wide diastasis of fragments which did not interfere with extension of legs (see text).

knee is manipulated in the manner shown in Fig. 397. There is great pain on pressure over the fractured condyle. If the internal condyle is involved, there is abnormal mobility at the knee in an inward direction or the limb is found in a genu varum position. If the external condyle is broken, abnormal mobility in an outward direction is to be found and the limb is held in a genu valgum position. Unless the swelling of the knee-joint is too great, one can palpate the displaced condyle and in some cases elicit distinct crepitus.

If both condyles have been broken and the shaft has been displaced upward between them, there is widening of the knee-joint.

Separation of the upper epiphysis of the tibia, of which twenty-six cases have been reported, is, like that of the lower epiphysis of the femur, a serious and often fatal injury.

The swelling of the knee-joint is usually considerable. Mobility of the epiphysis, most noticeable in a lateral direction, is, as in other epiphyseal separations, the most trustworthy sign, according to Poland. Crepitus of a soft muffled character can be detected in many of the simpler cases in which mobility of the epiphysis is present. Dislocation of the knee is scarcely known in children and the free movement of the joint in cases of separation suffices to exclude this form of injury. When there is little or no displacement or mobility, the injury may be mistaken for a sprain of the knee. Osgood has recently called attention to a peculiar partial separation of the tongue-shaped portion of the upper tibial epiphysis in young athletes. Clinically acute pain is felt in the knee, referred to below the patella. It is accompanied by slight swelling of the joint and there is considerable weakness on exertion.

FIG. 399.—CASE: FRACTURE OF THE PATELLÆ. Moderate separation of the fragments of each knee-joint. Useful legs (Scudder).

FIG. 400.—OUTWARD DISLOCATION OF THE PATELLA (Hoffa).

Avulsion of the tubercle of the tibia oc-

curs in the young. The diagnosis can be made by the recognition of independent mobility of the tubercle, inability to use the limb, and swelling of the knee-joint.

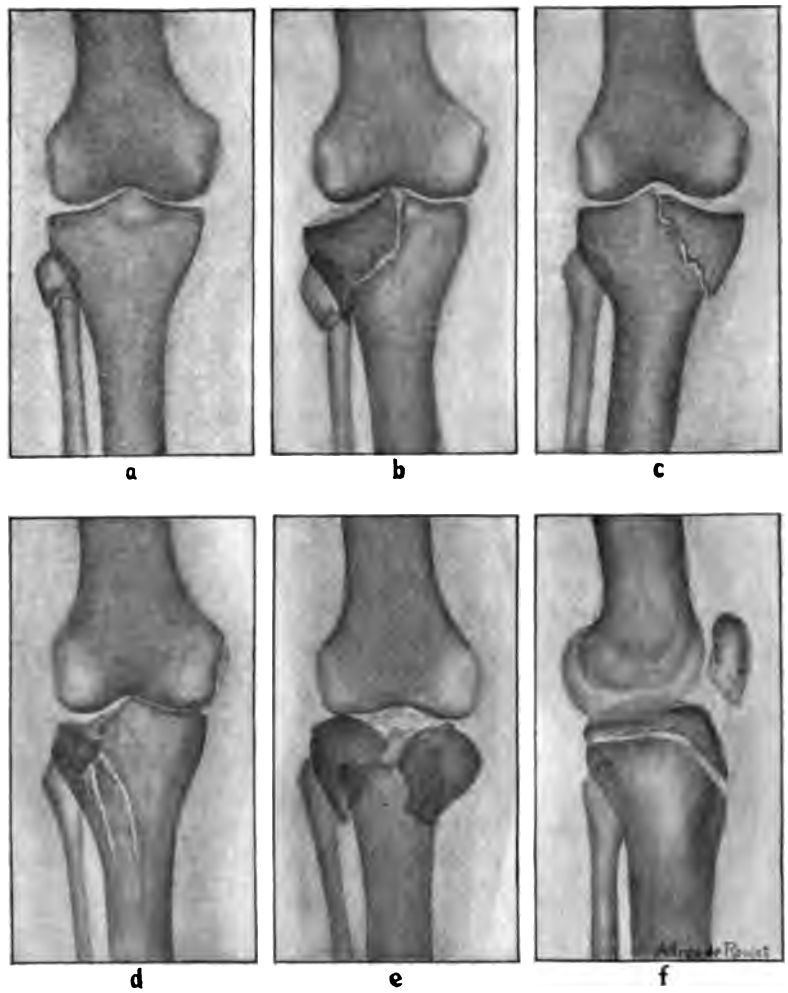


FIG. 401.—VARIOUS FORMS OF FRACTURES OF THE UPPER END OF THE TIBIA AND FIBULA NEAR THE KNEE-JOINT.

A, Fracture of the upper end of the fibula alone. B, Fracture passing through the outer tuberosity of the knee-joint, accompanied by fracture of the upper end of the fibula close to its head. C, Fracture passing through the inner tuberosity of the tibia, with displacement of the leg outward, resulting in a genu valgum position. D, Multiple crushing fracture of the outer tuberosity of the tibia. E, Multiple crushing fracture of the upper end of the tibia, extending into knee-joint. The lower fragment composed of the shaft is forced upward between the two upper fragments, composed of the tuberosities. F, Side view of separation of upper epiphysis of tibia and the beak-shaped process of same.

In some cases there is only local pain and tenderness and the diagnosis cannot be made without the aid of a skiagraph.

Fractures of the upper end of the fibula occur either through muscular action of the biceps or more commonly through forcible adduction of the leg. The injury may be recognized by the presence of pain just below the head of the fibula, accompanied by the presence of a small, hard mass, movable from side to side, which is raised by extension, but sinks after flexion of the knee-joint. There is also abnormal lateral mobility

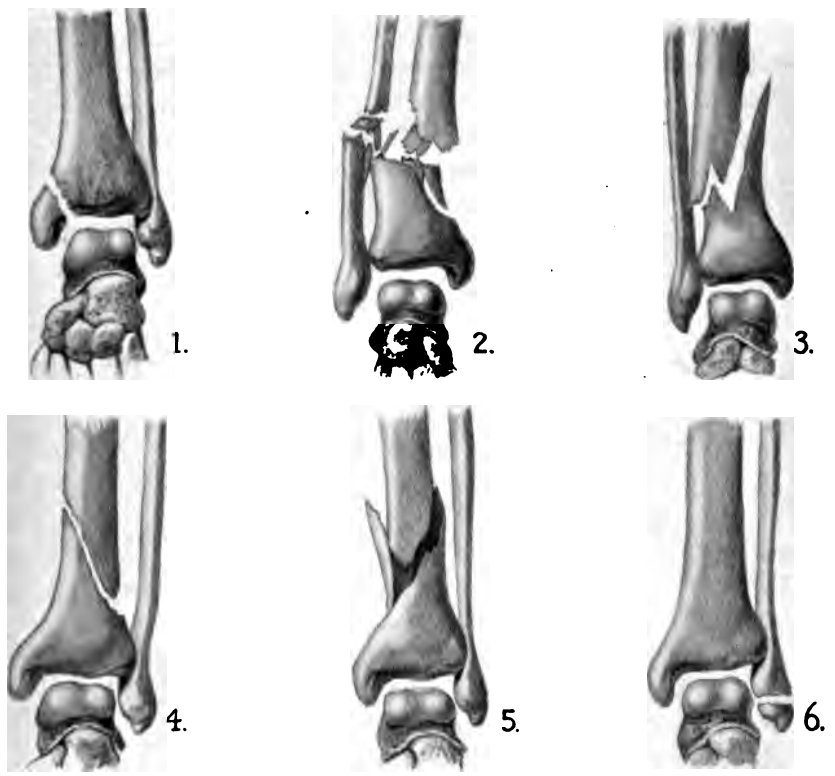


FIG. 402.—VARIOUS FORMS OF FRACTURES IN LOWER THIRD OF LEG.

Wash drawings made from skiagraphs. 1, Fracture of internal malleolus; 2, comminuted fracture of tibia and fibula at junction of lower and middle third; 3 oblique fracture of tibia with displacement of upper fragments outward; 4, oblique fracture of tibia without displacement; 5, spiral fracture of lower third of tibia; 6, fracture of external malleolus.

of the knee-joint. Not infrequently the injury is followed by paralysis of the muscles (peronei) supplied by the peroneal nerve, causing inability to raise the outer border of the foot.

Fractures of the Shaft of the Tibia.—These occur more frequently after direct injuries (when the limb is run over, or a heavy body falls on it) than after indirect injuries (such as a sudden abduction or adduc-

tion of foot). Both bones of the leg are usually broken after indirect violence, complete fractures are far more frequent in adults than in children.

The line of fracture is most often oblique (Fig. 404), although spiral fractures have been found in about one-seventh of all of the cases. This is important to diagnose by the use of the *x*-ray, owing to the fact that

FIG. 403.—COMPOUND (GUNSHOT) COMMINUTED FRACTURE OF THE LOWER THIRD OF THE TIBIA AND FIBULA.

The line passing across the upper portion of the plate is due to a defect. The black particles of the bullet fragments are well shown lying over the front of the tibia.

FIG. 404.—DEFORMITY FOLLOWING FRACTURE OF THE TIBIA AND FIBULA IN THEIR LOWER THIRD.

Note the double bony bridge uniting the two bones.

in the spiral form the fracture is much more difficult to reduce completely.

In the oblique form, the line of fracture runs from below and anteriorly backward and upward, so that the upper fragment is often displaced forward to such an extent as to lie directly beneath the skin.

Comminuted fractures, especially of the lower end of the tibia and

fibula, are not uncommon. The *diagnosis of a fracture of the shaft of one or both bones of the leg* is, as a rule, not difficult.

In many cases the deformity at the point of fracture and the outward rotation of the foot will permit a diagnosis to be made from inspection alone. In some cases of compound fracture the ends of the fragments project through the skin. By gently grasping the limb while the assistant supports the knee or ankle, abnormal mobility and crepitus can be readily elicited.

Shortening of the limb can be estimated by measurement from the upper border of the inner tuberosity of the tibia to the tip of the inner malleolus. The finger should also be passed along the tibia and fibula wherever they lie beneath the skin in order to detect any irregularity. In a few cases where the broken ends are dentated and displaced but little, one must be content, in the absence of a skiagraph, with making a diagnosis from the presence of localized pain and swelling followed by loss of function.

FIG. 405.—ANTERIOR VIEW OF DEFORMITY FOLLOWING POTT'S FRACTURE.

Note the change in the axis of the right or injured limb from the middle of the leg downward. This deformity was due to the displacement inward of the lower fragments of the tibia and fibula respectively.

When both bones are broken the abnormal mobility is usually much greater than is the case if the tibia alone is fractured. *Isolated fractures of the upper and middle thirds of the shaft of the fibula* are relatively rare. The diagnosis of such fractures depends upon the localized pain and the elicitation of crepitus and abnormal mobility on pressure.

It is of the greatest importance to combine the use of the *x*-ray with the above outlined external examination. It reveals many cases of in-

complete or subperiosteal fractures where none were suspected. It also yields much information as to the degree of displacement and the direction of the line of fracture, whether spiral, oblique, or transverse.

Separation of the lower epiphysis of the tibia is more frequent than is that of the upper. Deformity is the most marked sign, the foot and the epiphysis being displaced backward. The internal malleolus preserves its normal relations with the foot, but not with the

FIG. 406.—VIEW FROM OUTER SIDE OF DEFORMITY FOLLOWING POTT'S FRACTURE.
Note the prominence of the external malleolus, due to the displacement outward of both upper fragments, that is, of the tibia and fibula.

rest of the leg or the external malleolus. In gunshot fractures (Fig. 403) of the leg, the comminution of the tibia is usually much more extensive than is thought from external examination.

Injuries in the Vicinity of the Ankle-joint.—In the examination of a patient who shows evidences of injury in the vicinity of the ankle-joint, such as swelling, deformity, loss of function, etc., the following conditions must be thought of and excluded, in the order given:

1. Fractures of the lower ends of the tibia and fibula (Pott's fracture).
2. Dislocations at or near the ankle.
3. Fractures of the tarsal bones.
4. Rupture of the tendo Achillis. (See page 489.)
5. Sprains of the ankle.[1] (See page 519.)

1. Fractures of the Lower End of the Tibia and Fibula.—These are all given the name of Pott's fracture. They may be the result either

FIG. 407.—VIEW OF FLAT-FOOT DEFORMITY FOLLOWING POTT'S FRACTURE FROM THE INNER SIDE.

Note the bowing forward at the lower third of the anterior aspect of the leg. The arrow points to a frequent complication of fractures of the lower third of the tibia and fibula, namely, traumatic flat-foot. This is the same case as is shown in Fig. 406.

(*a*) of forcible abduction or eversion of the foot, or (*b*) of inversion or adduction. If the sole or main movement is eversion the internal malleolus is broken, and if the force continues to act it also causes the external malleolus to be broken. In the second variety, *i. e.*, fracture by inversion, the first effect of the force is to break the fibula (external malleolus). If the movement continues, the internal malleolus or a greater portion of the tibia is broken off.

[1] Sprains of the ankle are not infrequently accompanied by fractures of the lower end of the tibia and fibula which can only be recognized if an *x*-ray be taken.

There is usually no difficulty in making a diagnosis. The ankle-joint is greatly swollen, the depression normally present, in front of and behind the malleoli, being obliterated. The foot is displaced outward and the internal malleolus is prominent. This deformity will often persist and become a cause of disability after healing of the fracture (Fig. 405). There is also backward displacement of the foot (Fig. 408).

FIG. 408.—FRACTURE OF BOTH BONES OF THE LEG WITH MARKED BACKWARD DISPLACEMENT.

These displacements may be so marked as to resemble a true dislocation of the ankle at first glance. Abnormal lateral and antero-posterior mobility may be ascertained by grasping the sole of the foot (Fig. 413) with one hand and moving it inward or outward or backward and forward while the other hand steadies the leg. There is great tenderness between the tibia and fibula at the front of the ankle and over the points of fracture in the malleoli.

If the fibula alone is broken, abnormal mobility and crepitus may be

elicited by pressing its tip inward with the index-finger of one hand (Fig. 413) while a finger of the other hand is placed at the seat of fracture.

In some cases of Pott's fracture the foot will move inward instead of outward. The degree of backward displacement can be measured by the difference in the distance from the front of the ankle to the cleft between the first and second toes as measured on the sound and on the injured foot. There is not always complete loss of function. In fractures of the external malleolus alone the patient may walk quite well.

FIG. 409.—FRONT VIEW OF CASE OF SPIRAL FRACTURE OF BOTH BONES OF THE LEG JUST ABOVE ANKLE.

Note the upward prolongation of the posterior surface of both lower fragments, showing the spiral character of the fracture. Also note the outward displacement of the foot so frequent in unreduced Pott's fractures.

2. Dislocations at or Near the Ankle.—These injuries are very rare, constituting, according to the statistics of Krönlein, only about 0.5 per cent. of all forms of dislocations. The displacement may be complete or incomplete, the latter occurring more frequently. Dislocations at the ankle are often associated with fractures of one or both bones of the leg, especially of the malleoli.

Dislocations at the Ankle-joint (Tibiotarsal Dislocations).—They are best divided (*a*) into those which occur in a sagittal direction, *i. e.*, forward or backward, and (*b*) into those which take place laterally, *i. e.*, outward or inward.

(*a*) *Dislocations in a Sagittal Direction.*—In the forward variety (Fig. 415) the whole foot appears to be lengthened. The prominence due to the heel has disappeared. The upper articular surface of the astralagus can be felt, and the malleoli are nearer to the heel. It can be differentiated from a fracture of both bones of the leg above the malleoli by the fact that in a forward dislocation the malleoli are further back than normal, while in a supramalleolar fracture they have moved forward with the foot.

In the backward variety, the findings are opposite to those of the forward. The front portion of the foot is shortened (Fig. 415) while the heel is more prominent than normal. The lower end of the tibia protrudes over the dorsum of the foot and the sharp edge of its articular

surface is to be felt distinctly. The extensor tendons and the tendo Achillis are tense and prominent. It may be distinguished from a supra-malleolar fracture by the fact that the malleoli in the latter have moved backward with the foot, while in a dislocation backward they are prominent at some distance forward from the heel.

(*b*) *Dislocations in a Lateral Direction.*—The inward variety is very rare, only twenty-seven cases having been reported. It is not infrequently compound or associated with fractures of the tarsal bones or of the bones of the leg. The convex upper articular surface is prominent (Fig. 415) just below the outer malleolus.

FIG. 410.—SIDE VIEW OF SPIRAL FRACTURE OF BOTH BONES OF LEG WITH FORWARD DISPLACEMENT OF FOOT.

In the outward variety the most frequent form is that in which the foot is markedly abducted, much more so than in an ordinary Pott's fracture. The inner border of the foot points upward while the outer border rests upon the ground or table. The upper articular surface of the astragalus is to be felt just below the internal malleolus. A few cases have been reported. The abduction is so extreme that the toes point directly outward (Fig. 415), the foot forming an angle of 90 degrees with the leg. To this subvariety the term rotation-outward dislocation of the ankle has been given.

As is true of all varieties of injuries about the ankle or of the foot, the *x*-ray has been of the greatest aid in making an early diagnosis of the nature of the injury.

Subastragaloid Dislocations.—These occur in the astragalo-calcaneal joint (Fig. 416). There are two chief forms: viz., (*a*) the true sub-astragaloid, in which the astragalus remains in articulation with the tibia and fibula but is displaced from its articulation with the calcaneus. In the other form (*b*) the astragalus is completely separated from its relations to the bones of the leg and calcaneus. This latter is called

"total dislocation of the astragalus." The true subastragaloid dislocation may occur in one of four directions, viz., inward, outward, forward, and backward.

The most frequent of these (thirteen out of twenty cases reported) is the outward variety. They follow forced abduction of the foot, especially a fall upon the heel, while the foot is excessively abducted, or a blow upon the outer side of the leg, while the foot is fixed. The position of the foot is that of a well-marked case of flat-foot. The internal malleolus is nearer to the sole of the foot. In front of this malleolus, the head of the astragalus forms a prominence and the scaphoid is to be distinctly felt upon the sole of the foot. The injury is not infrequently compound, so that the astragalus presents in the wound.

FIG. 411.—FRONT VIEW OF A RECENT POTT'S FRACTURE, WITH SLIGHT DISPLACEMENT OF FRAGMENTS.

Note the swelling of the lower third of the left leg, and the obliteration of the normal depressions over the front of the ankle-joint, and above and below the malleoli, on the left or injured limb.

An important point in the diagnosis of subastragaloid dislocation is the absence of any prominence due to the projection of the body of the astragalus in front, behind, or on either side of the malleoli, as is the case in the tibio-tarsal dislocations described above. Another fact is the abnormal position of the calcaneus and scaphoid with relation to the malleoli and astragalus. The swelling is usually so great that a diagnosis is very difficult without the use of the *x*-ray.

Total dislocation of the astragalus is much more frequent than that of the tibio-tarsal or astragalo-calcaneal joint. The most frequent form is the outward. In this variety the foot is rotated markedly inward, *i. e.*, adducted and inverted, or club-foot position. The external malleolus is very prominent, and below it one can feel the dislocated astra[illegible]

3. Fractures of the Tarsal Bones.—After a fall from a height the tissues around the ankle-joint are often so enormously swollen that an

FIG. 412.—ONE OF THE METHODS OF EXAMINATION IN ORDER TO DETERMINE A FRACTURE OF THE EXTERNAL MALLEOLUS.

The method consists in making pressure upon the tip of the malleolus, as shown in the illustration, with the two fingers of one hand, while the other hand is placed at the suspected point of fracture. The hand placed over the tip presses it in and allows it to spring back, thus establishing a kind of lever action, which permits the other fingers to detect readily a false point of motion.

FIG. 413.—METHOD OF EXAMINATION FOR FRACTURE OF THE TIBIA OR OF BOTH BONES OF THE LEG CLOSE TO THE ANKLE-JOINT.

The foot is grasped by the left hand of the examiner when fracture of the left leg is suspected, while the right hand grasps the region just above the malleoli, so as to steady the limb during the time that the foot is being turned toward or away from the median line of the body, in order to determine false point of motion and crepitus.

exact diagnosis by palpation is very difficult. If by a systematic examination one has excluded all of the varieties of injuries just described,

one must not omit a careful search, aided by the *x*-ray, for fractures of the astragalus and calcaneus. These have been frequently overlooked, and not until ankylosis has occurred was the suspicion aroused that the case might have been more than a severe sprain. Fractures of the tarsal bones, especially of the astragalus and calcaneus, are not infrequently associated with one of the other injuries around the ankle, viz., fractures or dislocations of the tibia and fibula.

FIG. 414.—LATERAL VIEW OF AMOUNT OF FIXATION OF ANKLE-JOINT FOLLOWING MANY INJURIES IN CLOSE PROXIMITY TO THE SAME.

The lower one of the two limbs shows the degree of extension of the foot on the uninjured side. On the side of the fracture it can be readily seen that the amount of extension is practically lost, and that the foot is fixed at a right angle to the long axis of the leg.

The diagnosis of fractures of the astragalus can be most satisfactorily made if every injury about the ankle is systematically examined with the *x*-ray. If there is no displacement of fragments, a diagnosis is almost impossible at the time of injury, the case being usually diagnosed as a severe sprain. There is, however, more pain on pressure and upon flexing the foot, than is the case in a sprain, and not infrequently crepitus can be elicited. If there is displacement of fragments the diagnosis is a little less difficult, since one can at times feel the displaced fragments. In fractures of the neck of the astragalus, the foot is extended and [redacted]

while in those of the head or body, it is flattened or even in a pes valgus position, the malleoli are lower than normal, especially when the body is greatly comminuted (Fig. 423).

Fractures of the Os Calcis.—These are divided (*a*) into compression fractures of the body; (*b*) tearing fractures of the tuberosity; the latter is most apt to occur, as in the patient whose *x*-ray is shown in Fig. 419, by falling forward while the heel is fixed, and is often associated

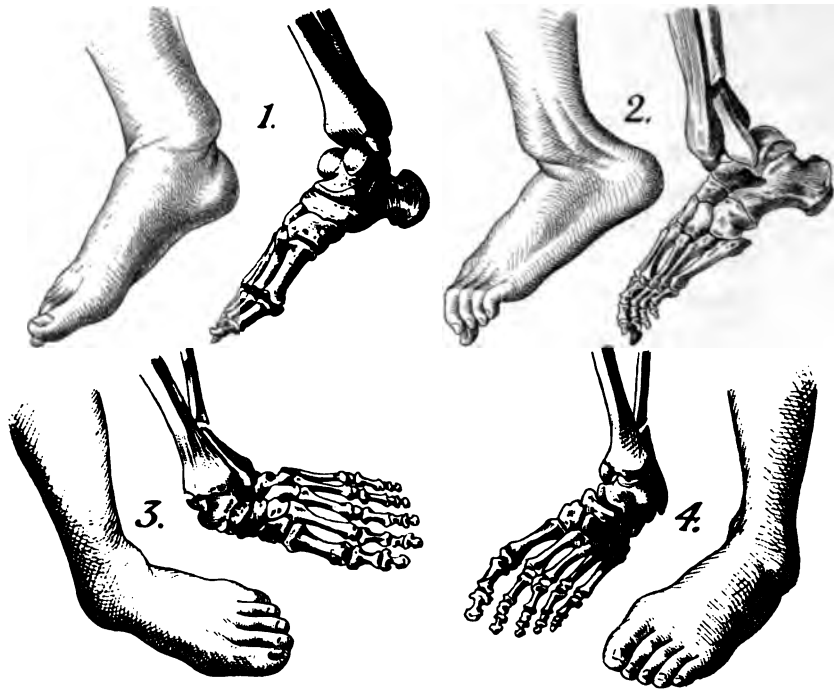


FIG. 415.—VARIOUS FORMS OF DISLOCATIONS OF THE ANKLE-JOINT (Hoffa).

1, Forward dislocation of the foot; 2, backward dislocation of the foot, associated with fracture of the fibula; 3, outward dislocation of the foot, associated with fracture of the tibia and fibula; 4, inward dislocation of the foot, associated with fracture of the tibia and fibula. (See text.)

with a tearing off of the attachment of the tendo Achillis to the os calcis. The diagnosis in the second variety is easier than in the crushing or compression fractures of the body of the bone. The detached fragment can often be felt just beneath the skin above the heel.

In both varieties the depressions below the malleoli are noticeably obliterated, there is marked swelling of the entire ankle (Fig. 422) and enlargement of the heel. The malleoli lie closer to the sole of the foot. There is marked tenderness on pressure of the calcaneus and severe pain

on walking. Passive adduction and abduction of the foot are especially interfered with and painful.

In both tearing and compression fractures the use of the *x*-ray is invaluable. One should, however, always compare this skiagraph with one taken of the normal ankle of the patient.

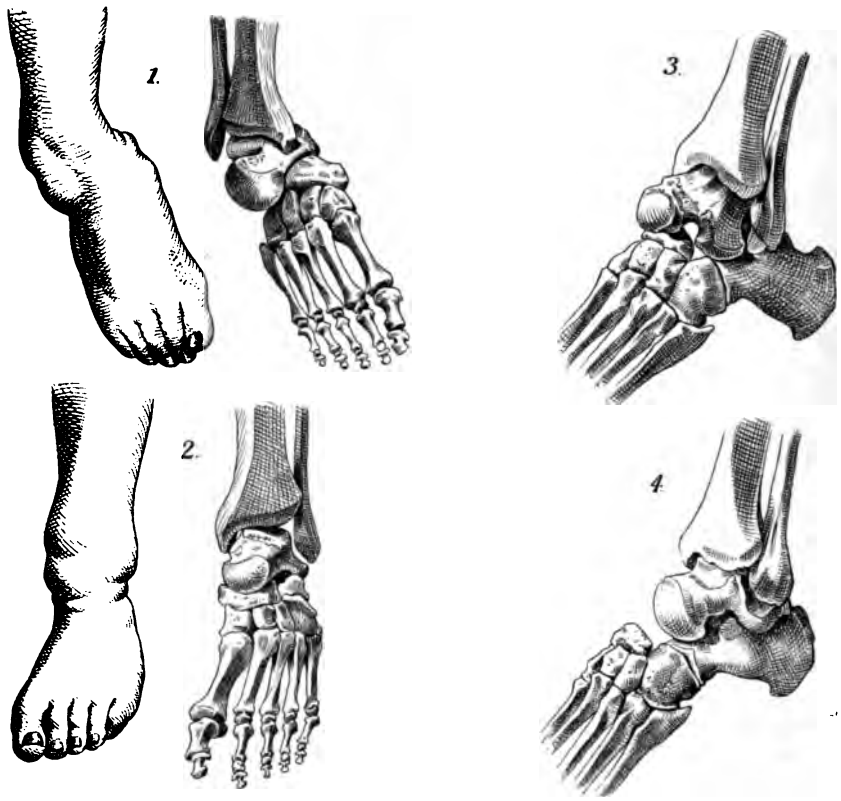


FIG. 416.—VARIOUS FORMS OF SUBASTRAGALOID DISLOCATION OF THE FOOT (Hoffa).
1, Outward; 2, inward; 3, backward; 4 forward.

Fractures of the Remaining Tarsal Bones, of the Metatarsals, and of the Phalanges of the Toes.—These occur from heavy weights falling upon the dorsum of the foot or from being run over. Fractures of the metatarsal bones may also result from jumping or from long marches, such as soldiers make.

In the case of the metatarsal bones the diagnosis is made from the presence of severe, well localized pain, swelling, and not infrequently crepitus and deformity. Standing upon the foot causes great pain. A

traumatic flat-foot may follow this form of fracture or large calluses develop on the sole of the foot over the seat of fracture. Fractures of the phalanges of the toes are usually the result of a crushing force and are often compound. They occur quite frequently when the toes encounter some blunt object like a table-leg, door, etc. The diagnosis is readily made by inspection and from the presence of a false point of motion and crepitus on manipulation.

FIG. 417.—X-RAY OF NORMAL FOOT AND ANKLE-JOINT VIEWED FROM THE OUTER SIDE.
F, Fibula; T, tibia; 1, astragalus; 2 os calcis; 3, scaphoid; 4, cuboid; 5, external cuneiform.

Dislocations of the Metatarsal Bones.—These may be either complete or incomplete at Lisfranc's joint. They occur most often in an upward direction and may follow such injuries as being run over, the fall of a heavy weight upon the foot, or forcible flexion of the foot. The dorsum of the foot is more convex than normal while the sole of the foot is flattened. One can see and feel the displaced upper ends of the metatarsals on the dorsum of the foot. The foot is shortened and the toes

point inward. Dislocations of the individual metatarsal bones are much rarer. The middle ones are displaced upward and the first and fifth inward and outward respectively.

Dislocations of the Toes.—These occur most often in the great toe after forcible dorsal flexion. The dislocation may be complete or incomplete. In the former case the proximal end of the first phalanx is prominent on the dorsum of the foot, and on the sole of the foot the head of the metatarsal bone projects.

FIG. 418.—SKIAGRAPH OF NORMAL FOOT SHOWING A BONY PROJECTION FROM THE ASTRAGALUS KNOWN AS THE OS TRIGONUM.

Often mistaken for a periostitis or a fragment of a fracture.

COMPLICATIONS OF INJURIES.

SHOCK AND HEMORRHAGE.

It is of the greatest importance to be able to recognize the presence of one or both of these complications clinically in order that the case may be intelligently treated.

The symptoms of hemorrhage into closed cavities, like the cranium, pleural, pericardial, and peritoneal cavities, have already been referred to. They do not differ in their constitutional signs from those following an injury of the extremities. In the latter, however, the symptoms of shock and hemorrhage often coexist, especially after severe crushing injuries, so that a differentiation is almost impossible.

The *most characteristic signs of hemorrhage* are the following:

1. Marked pallor of the skin and of the visible mucous membranes, such as the lips, gums, tongue, and conjunctivæ. The latter is best seen when the lower eyelid is everted.

2. The pulse is soft and rapid. It lacks its normal tone and the tension becomes less and less as the hemorrhage increases. If the primary loss has been very great the peripheral pulse may from the first be scarcely palpable and the heart-beats are very feeble.

3. The pupils are widely dilated and there is no response to light.

4. The mental condition varies. If the primary loss of blood has been moderate or even excessive, but there has been no further hemorrhage, the patient is apathetic, responds very slowly to external stimuli or to questions, or may even be in a deep stupor. If the hemor-

FIG. 419.—FRACTURE OF OS CALCIS (*x*-RAY) BY MUSCULAR VIOLENCE.

The white arrow indicates the direction of traction of the gastrocnemius and soleus muscles. The black arrow points to the characteristic elevation of the skin caused by the displacement upward of the fragment in such cases. 1, Fragment of os calcis; 2, main portion of bone; 3, astragalus; 4, 5, and 6, tarsal bones (cuboid, scaphoid, and cuneiform, respectively).

rhage continues this condition becomes one of deep coma, followed by convulsions and death. In some cases each fresh hemorrhage is accompanied by attacks of syncope or fainting from which the patient slowly recovers, but remains in a feeble condition.

5. Dyspnea is a very marked symptom, especially if the loss of

blood is a progressive one. This is often accompanied by great restlessness (even though the sensorium is benumbed) and by constant thirst.

6. There is usually a marked fall in blood-pressure.

The *most characteristic signs of shock* are:

1. The skin is cold, pale, and may be covered with perspiration.

FIG. 420.—COMPRESSION FRACTURE OF OS CALCIS, FOLLOWING FALL UPON THE FEET FROM A HEIGHT OF FORTY FEET.

a, Astragalus; c, c, c, fragments of os calcis.

The temperature is subnormal. There is pallor of the skin and visible mucous membranes, but this is less marked than in cases of hemorrhage. The pallor is often accompanied by more or less cyanosis.

2. The pulse is very weak, rapid, and often irregular or intermittent.
3. The pupils are widely dilated.
4. The mental hebetude is even more marked than in hemorrhage,

and it is difficult to arouse the patient. They are very apathetic and muscular relaxation is extreme. Less often there is slight delirium and great restlessness.

From the above it will be seen that the more important symptoms of shock and hemorrhage bear a great resemblance to each other. In many cases, especially of extensive wounds or crushing injuries of the

FIG. 421.—VIEW OF ANKLES FROM BEHIND.

The illustration shows the normal depressions to either side of the tendo Achillis, and between the lower border of the malleoli and the os calcis. These depressions are all partially or entirely obliterated in sprains or in fractures of the tarsal bones. (See text.) *I*, Inner malleolus; E, outer malleolus; *A*, location of bursa between the point of insertion of tendo Achillis and os calcis, referred to as a painful spot in inflammations of the bursa (achillodynia).

extremities, they coexist. In such cases the persistence of mental torpor, rapid weak pulse, shallow breathing—even though the source of the hemorrhage has been checked and the loss partially compensated for by transfusions, etc.—should lead one to suspect the coexistence of shock.

There are apparently two classes of cases of shock—(*a*) the erethistic, and (*b*) the ordinary or torpid form. In the former the restlessness, pallor, etc., can scarcely be distinguished from that of hemorrhage. In the torpid or apathetic form, the mental condition is one of more

marked stupor, and the muscular relaxation and weakness are more pronounced symptoms.

In some cases the symptoms of shock pass over into those of septic infection. The pulse-tension is then increased, delirium becomes a more marked symptom, and the pulse-rate rises rapidly. The marked increase in temperature as taken per rectum and the presence of leukocytosis serve to distinguish it from shock. Fat embolism has already been referred to (page 508) as a complication of fractures, and may simulate the symptoms of shock or be obscured, at first, by those of the latter condition.

Cyanosis is a more constant symptom of fat embolism than of shock. The respiration is also stertorous and rapid, while it is shallow and slower in shock. The diagnosis of fat embolism can be confirmed by finding free fat in the urine.

The pulmonary symptoms are usually more marked in fat embolism than in shock. They are either great dyspnea and asphyxia or those of pulmonary edema with expectoration of frothy, blood-stained mucus. In some cases cerebral symptoms predominate.

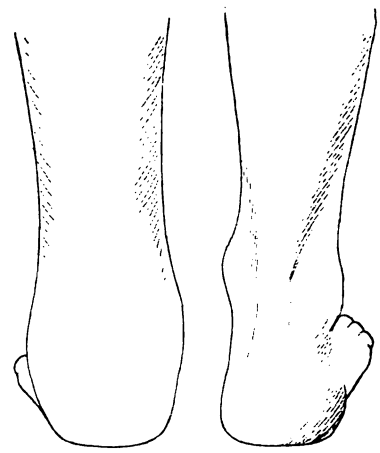


FIG. 422.

Outlines of normal ankle shown on the right, and of characteristic obliteration of depressions on either side of the tendo Achillis which occurs in severe sprains of the ankle-joint, with or without fracture of either bone of the leg, or fractures of the tarsal bone.

TRAUMATIC DELIRIUM AND DELIRIUM TREMENS.

In addition to the delirium often accompanying head injuries, a distinct form exists which follows both injuries and operations in those not admitted to be alcoholics, and has been termed *traumatic delirium.* It is especially frequent after injuries of the extremities in the young and in the aged, and after extensive burns at all ages. If it exists more than a few hours after an injury, other causes should be sought for, such as great loss of blood, septic infection, suppression of urine, acetonemia, iodoform absorption, or senile atrophy of the brain in the aged. If these can be excluded, the case must be considered as one of true nervous traumatic delirium. The latter is of a low, muttering character without fever. Its etiology is not quite clear.

The recognition of delirium tremens is not difficult. It most often follows fractures. The condition rarely begins suddenly and then only after a severe loss of blood. Most frequently the onset is gradual in chronic alcoholics. The patients are at first restless, even very talkative, rarely depressed. They complain of not being able to sleep, and soon

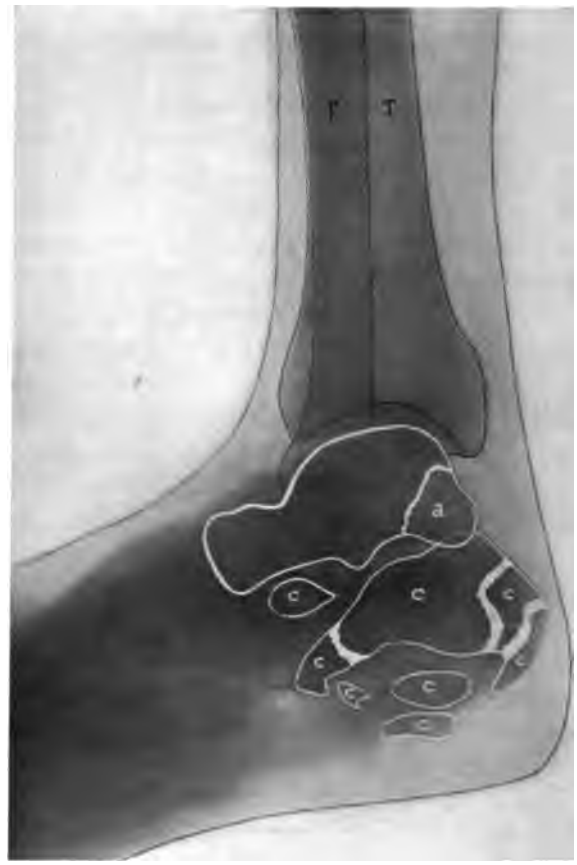


FIG. 423.—COMPRESSION FRACTURES OF THE ASTRAGALUS AND OS CALCIS, FOLLOWING A FALL OF EIGHTY FEET.

F, Outline of fibula; T, tibia; a, posterior fragment of fractured astragalus. The various letters *c* represent the comminuted fragments of the fractured os calcis.

begin to show marked tremors and become delirious. There is now complete insomnia, constant low, muttering delirium, or loud outcries. Efforts are made to get out of bed, accompanied by cries and marked tremor. Hallucinations and illusions are constant, and there is incessant muscular activity accompanied by an increase in the pulse-rate, cyanosis,

etc., until death ensues, unless the treatment has succeeded in controlling the disease. If high fever is present one must suspect the coexistence of septic infection or of a pneumonia, which may end by crisis.

INFECTIVE COMPLICATIONS OF WOUNDS.

The various tissues of the extremities are subject to the same varieties of infection as have been referred to in the head, neck, thorax, and abdomen. The chief differences are: (*a*) the extremities are more frequently

FIG. 424.—METHOD OF EXAMINATION FOR FRACTURE OF THE METATARSAL BONE.
The foot is grasped between the fingers of the two hands in order to determine the false point of motion and crepitus.

the seat of injuries than are other portions of the body; (*b*) the anatomic conditions are such that the spread of infection is greatly favored. This is especially true of infection in the upper extremity.

Infections of the extremities have two modes of origin: (*a*) from without inward, as occurs after operations or injuries, or (*b*) the limb is the seat of a local process which results from some systemic infection. The second mode of origin is far less frequent than the first-named.

It is important to remember from a diagnostic standpoint that the clinical course of an infection varies greatly.

1. It may remain local throughout its course.
2. It may become general, as, for example, hydrophobia, glanders,

anthrax, emphysematous cellulitis, malignant edema, and the more virulent forms of streptococcus and staphylococcus, or bacillus pyocyaneus infections. In this second group the organisms may give rise to a very characteristic clinical picture, or the general infection or absorption of toxins (as the case may be) present the features of a sapremia, septicemia, or septicopyemia.

A focus of infection which may have been comparatively insignificant in its incipiency may later give rise to the most grave forms of general infection, so that a thorough knowledge of the chief diagnostic features of both local and general infections is essential.

Local Infections in the Upper and Lower Extremities.—The organisms most frequently concerned in these infections are (*a*) the staphylococci and streptococci. Among the rarer bacterial agents are (*b*) the bacillus pyocyaneus, streptococcus, erysipelatis, bacillus of mailgnant edema, bacillus aërogenes capsulatus, pneumococcus, colon bacillus, gonococcus, influenza bacillus, bacillus of anthrax, and typhoid bacillus.

Infections due to the organisms of erysipelas, malignant edema and the bacillus aërogenes capsulatus result in such typical clinical pictures that they will be described separately. The diagnosis of whether an infection is due to the other organisms mentioned in the second group can only be made if (*a*) a primary focus exists elsewhere and (*b*) if the organisms are found either by microscopic examination of the pus or by bacteriologic tests. Infection with the bacillus pyocyaneus, may be recognized by the bluish or bluish-green color of the pus and a peculiar sour odor.

Staphylococcus and streptococcus infections are greatly influenced by anatomic conditions and by their own special characteristics.

In a general way it may be said staphylococcus infection is usually more circumscribed, does not spread as rapidly, and produces a thicker pus than is the case with the streptococcus pyogenes. The latter form of infection is, as a rule, far more virulent, extends along the surface (especially by way of the lymphatics and in the subcutaneous connective tissue) much more rapidly, and produces, if in pure culture, a thin turbid serum, which is not recognized as pus by the inexperienced operator.

A staphylococcus infection in the extremities is much more apt to spread along tendon-sheaths and intermuscular septa than is, as a rule, the case with the streptococcus. In the upper extremity infection may occur either through a wound or through a hair-follicle. The wound may be an extensive one, or even microscopic in size.

A reference to Fig. 425 will show the chief anatomic points and modes of transmission of infection from the fingers to the forearm, etc.

The clinical forms are: (*a*) In the epidermis; (*b*) in the subcutaneous connective tissue; (*c*) subperiosteal; (*d*) along the tendon-sheaths; (*e*) around the matrix and beneath the nail, and (*f*) between the muscles of the hand, forearm, and arm.

(*a*) *Epidermal Infection.*—This can be recognized clinically by the presence of blisters or bullæ which contain pus. If the entire epidermal covering is removed, the deeply injected upper layers of the rete malpighii are exposed.

(*b*) *Injection of the Cutaneous and Subcutaneous Tissues (Cellulitis of Finger or Hand).*—This not infrequently follows an insignificant punctured wound, or it may follow an incised wound or a lacerated contused wound or even a simple contusion.

FIG. 425.—RELATIONS OF FLEXOR TENDON-SHEATHS TO HAND AND FOREARM.

1, Flexor tendon-sheath of little finger extending through annular ligament to lower third of forearm; 2, flexor tendon-sheath of thumb extending to lower third of forearm. 1 and 2 often communicate. 3, Flexor tendon-sheaths of index-, middle, and ring-fingers, terminating at middle of palm of hand, and beginning again just distal to the wrist-joint.

On account of the anatomic fact that the connective-tissue fibers on the flexor surface of the fingers run at right angles to the bone the infection is more frequently carried directly to the periosteum or the tendon-sheath than is the case on the dorsum of the finger. On the latter surface it is more likely to spread along the lymphatics in an upward direction, or remain localized in the form of a furuncle in the subcutaneous tissue. The possibility of such insignificant foci on the dorsum of the fingers or hand being the starting-point of a lymphangitis or cubital or axillary lymphadenitis must be constantly borne in mind. The case may be seen at a time when the primary

focus has healed and the most prominent symptom is a suppurative cubital or axillary lymphadenitis.

If the pus is present in the subcutaneous tissue the skin of the finger, hand, or forearm is indurated, very tender to the touch, feels hot, reddened, and there is a constant throbbing pain. If complicated by a lymphangitis a red streak can be seen spreading over the hand and forearm to the cubital or axillary lymph-nodes.

If the infection has extended through the periosteum of the phalanges a so-called *felon* results. This can be recognized before incision by the intensity of the pain, which is far greater than in the other forms. If the felon or, as it can be more correctly termed, suppurative periostitis of a phalanx has been incised or the pus has been spontaneously evacuated a sinus lined with exuberant purulent granulations remains, which may persist for months until the sequestrum has been removed or discharged spontaneously.

If the infection is in the palm of the hand, the swelling of the dorsum is often so great that it would appear as though the infection were on this side.

(*c*) *Along the Tendon-sheaths.*—Infection, as a rule, spreads along the flexor tendon-sheaths, on account of the anatomic fact that the latter extend almost to the end of the fingers on the palmar surface, while on the dorsal surface of the fingers the extensor tendon-sheaths terminate at the middle of the back of the hand.

In virulent cases, the infection may spread in twenty-four hours from the finger-tip to the forearm. This condition can be recognized from the fact that the entire finger is swollen on its flexor surface and the interphalangeal folds are effaced. The palm of the hand along the course of the tendon is tender and swollen, and examination of the wrist will reveal an area of redness and tenderness extending to the beginning of the forearm. Such an involvement of the tendon-sheaths also causes marked swelling of the dorsum of the hand and a rise in the patient's temperature.

(*d*) *Ungual and Subungual Infection.*—The first result of an infection here, is to cause pain referred to the matrix of the nail. Considerable pus may accumulate beneath the nail, so that pressure upon the nail at its matrix will show a ballottement similar to that of a patella floating on fluid in the knee. If the matrix is completely detached, it can often be separated from its bed by pushing back the fold of skin at its base. Not infrequently a sinus or ulcer will form, as in the case of a felon, covered with exuberant granulations, and persisting for weeks or even months until the dead nail is removed (Fig. 426). The author has seen a number of such cases in which a diagnosis of chancre, etc., had been wrongly

FIG. 426.—ULCER OF TOE, WHICH WAS THE EXTERNAL OPENING OF A SINUS LEADING TO A DEAD NAIL, THE RESULT OF A PARONYCHIA OR OF A SUPPURATIVE ARTHRITIS OF THE DISTAL INTERPHALANGEAL JOINT.

[illegible]

c. Between the Muscles and Tendons of the Forearm and Arm. This has been termed an intermuscular phlegmon. It may be due to extension of infection from the hand or be the result of an infected wound or some form of suppuration in the forearm itself.

Not infrequently an infection of the subcutaneous connective tissue coexists. Unless attention is paid to the fact that free incision of the

FIG. 427.—PHLEGMON OF ARM CAUSING ENORMOUS SWELLING, MOST MARKED IN CLOSE PROXIMITY TO THE ELBOW-JOINT, DUE TO THE LODGMENT OF A SEPTIC EMBOLUS, SECONDARY TO A GANGRENE OF THE LUNG.

more superficial infection produces no change in the symptoms of septic intoxication (fever, rapid pulse, etc.) the deeper phlegmon is often overlooked until too late. The latter causes considerable swelling and tenderness of the forearm and arm proper. This is most marked around the wrist- and elbow-joints.

Pain in these cases of deep-seated infection is not very marked, the most prominent symptoms being the swelling, tenderness, and the persistence of high fever. If there is much accompanying involvement of the cutaneous and subcutaneous tissues, the skin of a deep red color, indurated, and the tenderness on pressure more marked. It is often necessary to diagnose [illegible] phlegmon, from erysipelas and [illegible]

phlegmons in the lower extremity. In the case of erysipelas, the infiltration of the skin is firmer, has a glazed appearance, and the red color is of a darker hue and is less diffuse than in phlegmon. Another point of difference is that *in erysipelas, the line of demarcation between infected and non-infected skin is quite sharp.* The edge is often raised above the level of the surrounding skin and is irregular. In a phlegmon, the edge passes imperceptibly into that of the surrounding skin and is not elevated or irregular.

Infections of the interphalangeal and metacarpo-phalangeal joints do not differ from those of joints elsewhere and will be considered in the diagnosis of purulent arthritis in general.

Infective Processes in the Lower Extremities.—Infection with the ordinary pyogenic organisms is much less frequent than in the upper extremities. They may originate (*a*) from an ingrown toe-nail or an abrasion of the foot with lymphangitis extending to the inguinal lymph-nodes as a red streak; (*b*) as a complication of compound fractures; (*c*) from an inflamed varicose vein or an infected ulcer of the leg; (*d*) secondary to an osteomyelitis, usually of the tibia or femur. Of the above atria of infection, the first-named group is the most frequent. The arrangement of the tendon-sheaths of the flexor and extensor muscles of the foot and toes is such that infection rarely travels upward through these channels. Infection in the lower extremities is much more apt to be transmitted along the lymphatics and in the loose-meshed subcutaneous connective tissue than is the case in the arm. In children and young adults, the rapidity with which infection spreads is much greater than in later life.

Attention has already been called to the fact that suppuration of the cubital and axillary lymph-nodes may not occur until two to three weeks after the primary focus was noticed. The same is true of the lower extremities, especially in children. A case may present itself for diagnosis with inflamed lymph-nodes in the subinguinal region (Scarpa's triangle) in which an infected abrasion or an ingrown toe-nail was either not observed or had already healed.

Another valuable diagnostic point in connection with infection in the lower extremities is the fact that the pus may extend into the deep lymph-nodes lying within the pelvis (deep iliac group) from the external (superficial inguinal) set (see fig. 455) and cause long-continued fever and other signs of severe sepsis before they are recognized, by finding a tender mass upon deep palpation of the iliac fossæ. Infection of the prepatellar bursa and of the knee-joint occurs far more frequently as a complication of suppuration in the lower extremity than is the case with similar bursæ and

joints of the upper extremity. The diagnosis of these conditions is considered on page 644.

The diagnosis of subungual and periungual suppuration and infection of the interphalangeal and metatarso-phalangeal joints does not differ from that of the same conditions in the upper extremities. They show, in general, less of a tendency to spread. Ingrown toe-nail, which is a form of subungual infection, is readily recognized from the local pain, redness, and the exuberant granulations along the side of the nail. A dead nail, as in the fingers, may cause a long-continued ulceration of the neighboring tissue (Fig. 426).

Emphysematous Cellulitis and Malignant Edema.—These are rare, but yet frequent enough forms of infection of bullet wounds, compound fractures, abrasions, etc., to demand careful consideration. In the majority of text-books, no distinction is made between emphysematous cellulitis produced by the bacillus aërogenes capsulatus, and the rapidly spreading gangrenous form of infection due to the bacillus of malignant edema. Both lead to gangrenous processes in an arm or leg following one of the above varieties of wounds, and are accompanied by a hemorrhagic exudate and the development of gas in the tissues. The condition may be recognized (*a*) by the rapidly spreading discoloration, swollen condition of the limb, and early gangrene; (*b*) by the crepitation on pressure when the limb is palpated; (*c*) from the foul-smelling hemorrhagic serum which exudes from the wound, and (*d*) from the early onset of marked septic symptoms, such as high temperature, rapid pulse, delirium, and marked leukocytosis. Death may take place within a few days unless amputation be performed. The diagnosis of which organism is concerned, should be made as early as possible by making cover-slip preparations of the bloody serum and cultures on anaërobic media. If death does not ensue from the immediate virulence of the infection, the case may pursue a more protracted typhoid-like course.

Erysipelas.—This form of infection, like those due to the ordinary pyogenic organisms, may be a complication of operations, of ulcerative processes, of compound fractures or any form of injury of the extremities. It occurs less frequently in the upper or lower limbs than on the face.

Erysipelas most often begins with a chill and a reddening of the edges of the wound, accompanied by a rise of temperature. Within a few hours the skin around the wound assumes its characteristic appearance, from a careful inspection of which the diagnosis can usually be made. The edges of the area of redness usually show a sharp demarcation from the normal skin. The edge is raised above the surrounding level and often shows irregular prolongations, giving it a jagged appearance. Red

streaks can frequently be seen running toward the regional lymph-nodes from the area of infection. They are due to an involvement of the lymph-vessels (lymphangitis). In many cases the erysipelatous redness spreads from day to day, becoming paler where the limb was first involved.

In healthy individuals the color of the area is of a deep reddish hue. In those with a tendency to venous congestion, it has a bluish tint, while in anemic or cachectic persons it is of a light red shade. Over this area numerous vesicles or even bullæ are found. The swelling of the skin is usually marked, so that the infected area feels tense, glistens and does not pit on pressure. The following may be mentioned as not infrequent local complications in the severer cases: abscesses in the subcutaneous tissue, infection of tendon-sheaths, intermuscular spaces, and joints, as well as gangrene of the skin. The latter is most apt to occur in the finger-tips.

The symptoms of general infection in erysipelas are: (*a*) The presence of more or less fever of a continuous type. The rise of temperature is less often of a distinctly remittent type and is accompanied by repeated chills. (*b*) A rise of pulse-rate accompanies the fever. (*c*) Delirium is often present, especially in elderly persons and in those cases characterized by marked septic symptoms and high fever.

Among the complications, whose possible appearance must be constantly looked for during the course of the disease, are pneumonia, ulcerative endocarditis, septicemia, and less frequently pleuritis, meningitis, and nephritis.

The differentiation of erysipelas from a phlegmon is not difficult, as a rule. In erysipelas the skin is often covered with blebs, the redness is of a bright, glistening character, and the border is more or less jagged or irregular and sharply marked off from the healthy skin. In a streptococcus phlegmon, from which the differentiation must usually be made, the induration is more board-like, and the redness is of a darker hue. In addition, the skin does not glisten, seldom has blebs, and the area of redness shows no sharp line of demarcation, as in erysipelas.

Erysipeloid.—This is a form of wound infection which often occurs in cooks, butchers and others who handle game, fish, and oysters. It is usually found on the fingers as a dark red swelling with quite a sharp border. It gradually extends from the finger upon which it happens to begin to the remaining fingers and to the hand, as in a true erysipelas. The disease lasts about three weeks and ceases spontaneously. There is but little general disturbance. Locally the patients complain of tingling and itching.

The diagnosis is usually easy from (*a*) its location on the fingers or hand; (*b*) the occupation of the patient; (*c*) the absence of fever;

(*d*) the bluish redness of the eruption and its slow spreading with only a minimal amount of infiltration of the skin.

From erysipelas it can be differentiated by the absence of fever, its slow spreading, and the fact that it lacks the bright redness, tension, and glistening appearance of an erysipelatous area.

Sapremia, Septicemia, and Pyemia.—Infection of a wound either sustained through injury or subsequent to an operation; by any of the organisms just referred to, may be followed by one of three groups of symptoms. They may also follow any of the acute forms of bone infection.

Sapremia means a local infection with the development of toxins. This condition is present if fever develops after the infliction of a wound, accompanied by other general symptoms, such as malaise, rapid pulse, restlessness, headache, and prostration. Locally one finds all of the evidences of pyogenic infection described on page 609. The gravity of the initial symptoms varies according to the amount of toxins absorbed. Instead of high fever, etc., one may find collapse, coma, and death, or the condition passes imperceptibly into one of septicemia or of septicopyemia. If the sapremia is of a moderate type, and due to imperfect drainage of a wound, it is often characterized by a regular evening rise of temperature and a considerable degree of leukocytosis, which persists until the wound is opened and drainage established.

The most important differential point between sapremia (septic toxemia) and septicemia (bacteriemia) is that when thorough treatment of the focus of infection has been instituted the symptoms of fever, etc., disappear in sapremia, but show no improvement in septicemia.

In sapremia the signs of local infection predominate, while in septicemia it is the symptoms of general infection which attract attention.

Septicemia.—In this form of infective complication of wounds there is a constant formation of toxins in the blood itself, due to the bacteriemia which exists. *The eradication of the primary focus does not cause a termination of the symptoms as in sapremia.* Such a step has but little influence upon the course of either septicemia or the form to be next described, septicopyemia. The chief diagnostic features of a progressive septicemia are the following:

1. *Fever.*—Usually this is of a continuous type. The occurrence of chills is not characteristic of septicemia, although it occurs at times.

2. *Pulse.*—This is at first full, somewhat increased, and shows tension. As the infection progresses, it is soft, lacks tension, becoming weaker and more rapid. The rapidity of the pulse is in general a good criterion of the severity of the infection, being 140 to 160 in the graver cases.

3. *Mental Disturbances.*—Headache and mental dullness are

common, but not infrequently unusual clearness and activity of the mind continue throughout the greater part of the illness. If mental stupor exists, it is often accompanied by delirium, and may develop into deep coma.

4. *Alimentary Canal.*—The tongue is dry and covered with dirty brown crusts. The breath is offensive and often has a peculiar sweetish odor. There is complete anorexia, accompanied either by constipation or by diarrhea (septic enteritis).

5. *Kidneys.*—The urine is scanty, high-colored, and contains much albumin and many hyaline and granular casts.

6. *Blood.*—There is usually a moderate degree of leukocytosis (15,000

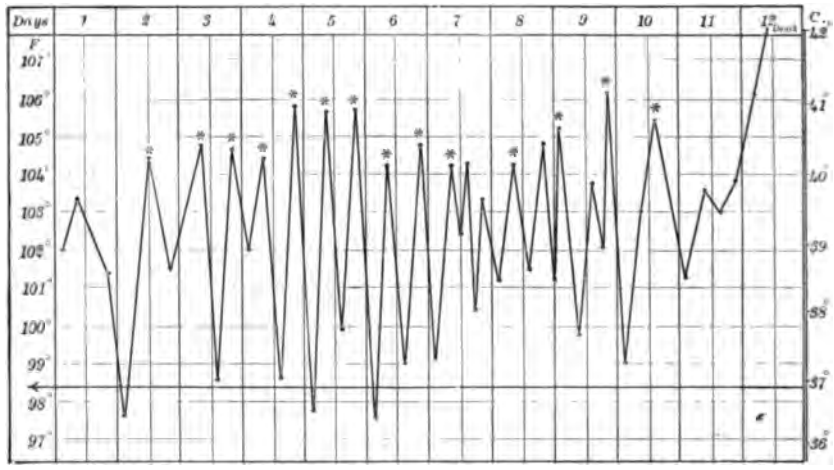


FIG. 428.—TEMPERATURE-CHART IN A CASE OF PYEMIA WITH MUSCULAR LOCALIZATIONS.

* indicates a chill. The fall of temperature was frequently due to the use of the cold pack ("International Text-book of Surgery").

to 20,000). The organisms concerned in the process may be demonstrated in pure culture by aspirating blood from one of the arm veins and inoculating blood-serum, agar, and other media.

7. *Appearance of Wound.*—The wound secretions are often malodorous, thinner, and smaller in quantity. The arm or leg may show local evidences of an extensive progressive phlegmon of the most septic type.

In the most virulent forms of streptococcus malignant edema or bacillus aërogenes capsulatus infection, the local signs are often the most prominent feature of the clinical picture.

Septicopyemia or Pyemia.—This condition is understood to be general infection resulting from the entrance into the circulation of septic thrombi containing the ordinary pus cocci. These infected thrombi when

carried to distant points form independent centers of suppuration. In the extremities such a pyemia or, to use a better term, septicopyemia may arise (*a*) from an infected wound of the skin or deeper structures, (*b*) from an osteomyelitis, (*c*) from a septic thrombophlebitis, *e. g.*, of a varicose vein.

The chief features of the disease as compared with septicemia are the occurrence of chills, and of an irregular, more remittent type of temperature. Accompanying these general symptoms are the local ones due to the deposit of the infected thrombi in the lungs, endocardium, liver, spleen, kidneys, skin, and bones. These symptoms may appear at any period in the course of a wound. The disease may pursue a very acute, a subacute, or a chronic course, the latter lasting for years.

The chief diagnostic features of septicopyemia are the following:

1. *Fever.*—The onset is usually with a chill, followed by a rise of temperature to 103° to 105° F. and a profuse sweat.

This triad, viz., chill, fever, and sweat, is repeated at intervals, either daily or every other day. In the intervals, there may be a slight rise of temperature. In some cases, chills either do not accompany every rise of temperature or are entirely absent. If the latter is the case, there is persistence of the remittent type of fever. The rise of temperature may occur at any time of day and even two or three times within twenty-four hours. It is this irregularity which serves, taken in conjunction with the absence of plasmodia in the blood, to distinguish it from malaria.

2. *Pulse.*—If the pyemia occurs in a previously healthy individual the pulse is full and strong and rises to 120 during the fever, but may sink to normal in the interval. In the majority of cases, the pulse remains rapid throughout the disease.

3. *Mental Condition.*—In the most acute cases, a typhoid-like stupor exists, but in the subacute and chronic forms, the mind is much clearer than in septicemia. The patients are often fully conscious, anxious, and irritable. As they grow weaker, stupor and delirium set in and the sensorium becomes more and more clouded, until coma supervenes.

4. *Alimentary Canal.*—The most prominent symptoms are anorexia, nausea, vomiting, and rapid emaciation. Jaundice is a very characteristic sign of pyemia. This is the result of metastatic abscesses in the liver. Diarrhea is only present in the later stages.

5. *Kidneys.*—Traces of albumin and casts are found in the urine. In general the signs of the renal disturbance are less marked than in septicemia.

6. *Evidences of Metastases.*—These are very important to recognize, and have been referred to above. Pulmonary metastases reveal them-

selves clinically by the presence of dyspnea, cough, and blood-tinged sputum. If many abscesses exist, the physical signs of a lobular pneumonia are found, or evidences of a pleurisy. Embolic abscesses in the spleen cause localized pain and enlargement of the organ. Metastases in the liver produce, if small, local peritoneal friction sounds and tenderness. If larger, they cause increased dullness, swelling, and jaundice. Metastases in the skin, parotid, thyroid, testis, bones, and joints are easily recognized. A metastatic brain abscess is very rare and can only be diagnosed if it causes focal or general symptoms or intracranial pressure.

7. *Appearance of Wound.*—The secretion is diminished, the granulations appear pale, or flabby and necrotic.

8. *Blood.*—In pyemia there is marked leukocytosis, while in malaria and typhoid there are normal relations or leukopenia.

In the differential diagnosis of pyemia and septicemia from other affections one must remember the following:

Acute suppurative osteomyelitis.
Acute septicopyemia from gonorrhea.
Typhoid fever.
Ulcerative endocarditis.
Malaria.
Acute lymphatic leukemia.
Acute Hodgkin's disease.
Pyelonephritis and perinephritic abscess.
Septic pharyngitis.

The profound anemia and the intermittent fever sometimes seen in rapidly growing carcinoma may resemble chronic pyemia.

Tetanus.—This complication of accidental wounds occurs far less frequently at the present time than in the preantiseptic era. It most commonly follows wounds of the hands and feet, especially those in which the wound of entrance in the skin is comparatively small and closes at an early period, thus permitting the anaërobic tetanus germ to multiply in a closed cavity.

The possibility of symptoms of tetanus developing must always be borne in mind in punctured or blank cartridge wounds, in crushing injuries of the extremities, and in compound fracture, whenever there is any likelihood of street, garden, or stable dirt having been carried into the wound.

Tetanus may appear clinically in several forms, viz.: (*a*) *A very acute form*, in which the symptoms appear during the first eight days and the patients die within twenty-four to forty-eight hours after onset of the

tetanus symptoms. This class embraces about 33 per cent. of the cases. (*b*) *The typical form*, in which the first symptom appears between the eighth and fifteenth days after reception of the injury. About 45 per cent. of the cases belong in this group. (*c*) *The subacute or chronic form*, in which the first sign (lockjaw) appears in the third or fourth week after the injury. This form embraces the remaining 22 per cent. of the cases.

In spite of the variation in the time of onset and intensity of the individual symptoms in these three groups, there are certain constant signs from which a positive diagnosis can be made. They are:

1. A tonic spasm of the muscles of mastication, known as *trismus*, so that the patient is unable to open the mouth, a symptom so prominent that the disease is called by the laity, lockjaw. This symptom is gradual in its development. The patient is at first able to open and close the mouth, but not fully. This lack of control of the voluntary muscles, due to their spasmodic contraction, spreads to the muscles of the back of the neck, so that the neck cannot be flexed. The rigidity soon extends to the back and abdominal muscles. These become very hard and almost board-like from the tetanic contraction. The trunk becomes overextended through the spasm of the back muscles, so that the patient's weight rests upon the head and heels, a position called opisthotonos. When the spasm affects the muscles of the tongue, pharynx, larynx, and those of respiration, the speech becomes indistinct, and is accompanied by marked dyspnea. Asphyxia may occur from spasm of the glottis.

2. The second important symptom of tetanus, viz., increased reflex irritability and convulsions of a tonic and clonic character, appears soon after the trismus in those cases, in which death does not occur in twenty-four to forty-eight hours after onset of the first symptom. These spasms vary in duration and affect all of the tonically contracted muscles. Every irritation, such as a current of air or touching the patient, excites a convulsion.

3. The temperature is high, as a rule in tetanus, but there may be little or no elevation. There is a special class of cases, called *head or cephalic tetanus*, which follow wounds of the head, especially those around the eye or of the cranial nerves. The most prominent symptoms of this form are the appearance of spasms of the muscles of deglutition and a paralysis of the facial muscles on the side of the injury, in addition to the trismus or lockjaw. To this form of tetanus the name of *tetanus hydrophobicus* still clings, on account of its resemblance to true hydrophobia.

Differential Diagnosis of Tetanus.—(*a*) In strychnin poisoning the rigidity does not persist in the intervals between convulsions, and th[redacted]

muscles are not the first ones affected, as is almost invariably the case in tetanus. The muscles of mastication may not be involved at all in strychnin poisoning. (*b*) In tetany, the hands are held in a peculiar position, the wrists being flexed and the fingers extended at the interphalangeal, but flexed at the metacarpo-phalangeal joints. The tonic spasms occur at regular intervals, involve the extremities chiefly, and there are no general convulsions. Tapping upon the facial muscles or pressure upon the bend of the elbow or at the back of the knee will often cause the spasm to appear. (*c*) In symptomatic lockjaw due to reflex irritation of one of the branches of the fifth nerve, there is inability to open the mouth, as the result of reflex contraction of the masseter muscle. There is no history of a wound, no general rigidity, or spasms, and no rise of temperature. An examination of the mouth will soon enable a correct diagnosis to be made. This reflex trismus is often due to a stomatitis, either from lack of care of the mouth, the use of mercury, or the irritation due to the eruption of a wisdom-tooth.

Hydrophobia.—This disease occurs rarely as a complication of wounds of the face and extremities, but its early recognition is important. The proportion of persons in whom the disease develops is greater after bites from wolves (40 per cent.) than from dogs (5 to 15 per cent.). The average period of incubation is four to six weeks, rarely less (thirteen to eighteen days). A period of incubation of three to six, or even from six to twelve months is rare. As in the case of tetanus, there are no local changes in the wound which indicate the development of the disease. The wound appears red and swollen, and if it has healed may reopen and secrete a thin turbid pus. *Whenever possible after a person has been bitten, the animal should not be killed, but kept under observation for the purpose of noting the development of the symptoms of the disease.*

In man, the diagnosis is usually not made until the patient becomes very irritable, this condition being accompanied by a spasm of the muscles of the larynx and those of deglutition. When the patient is given some water to drink, the spasmodic and painful contractions of the pharyngeal muscles cause it to be expelled, so that the very sight of water becomes repulsive.

The diagnosis can be made from: (*a*) The history of the bite of an animal, even though it occurred weeks to months, prior to the onset of the symptoms. (*b*) A period of mental depression, followed by one of great mental irritability and anxiety. (*c*) The onset of the typical spasm of the muscles of deglutition whenever water is seen or an attempt made to swallow it. The patient can still swallow solids at first, but not liquids. (*d*) There is increased reflex excitability, not only of the sense of sight for

water, but also of other special senses, like those of smell, taste, etc., and of the sexual organs. Exhaustion from insomnia, with rapid increase in the pulse and respiration, gradually appears and is followed by death. The only condition which needs to be mentioned in the differential diagnosis is that of the so-called *cephalic or tetanus hydrophobicus* described on page 619, especially when it follows a dog bite. In this disease, there is the history of a wound of the head or one involving one of the cranial nerves, accompanied by paralysis of the facial muscles and trismus. In head tetanus and true hydrophobia there is spasm of the muscles of deglutition, so that in some cases the diagnosis depends on the trismus in tetanus. Occasionally, the spasms of the muscles of swallowing may be absent and yet the case be one of true hydrophobia.

Symptoms of difficulty in swallowing may appear in hysterical persons some weeks after being bitten by a dog. The clinical picture may at first resemble that of the genuine disease, but careful observation and a search for other stigmata of hysteria will soon clear up the diagnosis.

Anthrax.—This complication of wounds has been referred to on page 102. It may follow wounds of the face, hands, or arms. In addition to this *external or cutaneous form*, there are two other rarer clinical forms, the *alimentary* and *pulmonary*. These latter are fully described in text-books on internal medicine. The *cutaneous form* appears either as a pustule or as a rapidly spreading edema. The period of incubation varies from two to fourteen days, and upon inquiry one can usually obtain the history of a wound received while handling wool, sheepskins, infected meat, or manure.

In man, the diagnosis of anthrax can usually be made from the rapid change in the appearance of the wound. The site of inoculation begins to swell and itch as it does after an insect-bite. A blister appears at the apex of the papule and the area of induration around the wound of inoculation rapidly increases in extent, is of a bluish-red color, and becomes covered with vesicles. At the center of the area of infiltration, a black, gangrenous slough appears and rapidly increases in size. The infection soon extends into the adjacent lymph-vessels and regional lymph-nodes. Lymph-vessel involvement causes red streaks of lymphangitis to appear, while lymph-node infection is followed by pain and swelling of the regional nodes.

Accompanying these local changes, there is high fever, severe headache, delirium, a rapid weak pulse, and other septic symptoms, such as diarrhea. Death may occur quite early. The process may remain a local one, and instead of a central slough with a rapidly spreading area

of induration, covered with vesicles, one may simply find (*a*) a few vesicles with moderate inflammatory induration or (*b*) a small gangrenous center or (*c*) a peculiar edema, the so-called *anthrax edema*. In the latter, the swelling spreads very rapidly, especially where the connective-tissue fibers are loosely arranged under the skin. The edematous area is of a dark bluish color, and may be followed by extensive gangrene.

The diagnosis can usually be confirmed in all of the above forms, by the rapidity of the induration and sloughing, the occupation of the patient, and finding the bacilli either in cover-slip preparations or by culture tests.

Glanders.—This disease may appear in such an atypical manner and so unexpectedly that a short description of its principal diagnostic features is necessary.

If the disease is inoculated through a cutaneous wound in man, the wound soon ulcerates, and there is early swelling and tenderness of the adjacent lymph-nodes. The local ulceration spreads and greatly resembles a soft chancre. Soon after this, red papules (farcy buds) appear in various parts of the body, and soon form abscesses with resultant ulcers in the skin or deeper tissues. Accompanying these signs of a pyemia there is a thin mucopurulent discharge from the nose. Symptoms of septicopyemia appear in the majority of cases, followed by death. Less often the clinical picture is that of articular rheumatism or typhoid fever. In the chronic form the same symptoms, viz., widely scattered areas of induration and abscess formation, appear, accompanied by milder septic symptoms. The diagnosis can only be made by considering the occupation of the patient and finding the characteristic glanders bacillus in the nasal discharge or in the pus.

SURGICAL DISEASES OF THE EXTREMITIES.

AFFECTIONS OF THE SKIN AND SUBCUTANEOUS TISSUES.

Ulcers.—Ulcers are more frequently found upon the lower than upon the upper extremities. In the diagnosis of the cause and nature of an ulcer, the following must be considered:

(*a*) The previous history should be carefully taken to ascertain the circumstances attending the first appearance of the ulcer, whether it followed trauma or pressure, or whether it appeared spontaneously. The duration of the ulcer and its lack of tendency to heal, or its steady growth in size, are data of considerable value. The history will also throw light on any constitutional disease, such as syphilis, tuberculosis, diabetes, or spinal-cord affections.

(*b*) The examination of the edges of the ulcer as to the degree of induration and whether these edges are steep or undermined.

(*c*) The form of the ulcer, whether irregular, serpiginous, or reniform.

(*d*) The floor of the ulcer, as to the degree of sloughing, and the nature of the granulations covering it.

(*e*) The examination of the limb for varicose veins, for eczema, for evidences of arteriosclerosis, for syphilitic periostitis, etc.

The chief varieties of ulceration which occur on the skin of the extremities, and their clinical characteristics are:

1. *Traumatic Ulcers.*—These occur in persons with a lowered degree of resistance, or in limbs in which considerable venous stasis exists. In such individuals a wound may heal so slowly that epidermization is retarded, the edges become indurated and the granulation tissue flabby. In such persons, the diagnosis is not difficult if there is a distinct history of an injury with loss of skin, or when it follows a burn or freezing of the parts. The ulcers present no characteristic appearances, and in the absence of a history, a diagnosis as to the cause is impossible. In some cases the ulceration may spread and encircle the limb. In these a condition of elephantiasis (Fig. 439) often accompanies the ulcer, forming a vicious circle and thus increasing the venous congestion which prevents the healing of the ulcer.

FIG. 439.—VARICOSE ULCER OF LEG. (See text.)

2. *Varicose Ulcers.*—These are usually situated on the front of the lower third of the leg, but may be located over the malleoli. They are irregular in form, the edges are rarely sharply cut, *i. e.*, steep, and the floor may present a condition varying from a dirty sloughing appearance to a healthy, red, granulating surface.

The skin around the edges is usually of a bluish-red color, and indurated. It may show evidences of extensive brownish pigmentation and chronic eczema.

The diagnosis can be made from the presence of the accompanying varicosities in the area of distribution of either the internal or external saphenous veins, or of both. Various complications may call for recognition, such as acute inflammation of the skin around the ulcer, thrombosis of the varicose veins (see page 640) leading to it, or an erysipelas starting from the edge of the ulcer. Carcinomatous changes may also occur, and can be recognized by the rapid spread of the ulcerated area, the marked induration and elevation of its edges, and the enlargement of the regional lymph-nodes (Fig. 149).

Fig. 430.—Perforating Ulcer of the Foot in a Tabetic Subject (Matas).

In some cases varicose ulcers, like the more chronic variety of traumatic ulcer, may completely encircle the limb, and be associated with elephantiasis of the entire leg from the knee to the foot.

3. *Syphilitic Ulcers.*—If the characteristics of these are borne in mind, there is usually no difficulty in their diagnosis. Their outline is, as a rule, more regular than is the case with varicose ulcers. They are either round or serpiginous or kidney-shaped (Fig. 34). Their edges are usually so sharp and steep that they look as if they had been punched out with a die. The floor is covered with sloughing and fetid granulation tissue and the ulceration usually extends quite deeply into the tissues.

The absence of a history of trauma and a negative result in the search for evidences of varicose veins will often enable a differentiation from these two varieties of ulcerations to be made. There are many cases, however, in which the syphilitic ulcer appeared after an injury or is accompanied by varicose veins. In such cases the diagnosis can only be made if (*a*) there is a clear history of syphilis; (*b*) if the outline and edges

are as just described, and (*c*) if the ulcer shows marked improvement after the use of the iodids; (*d*) if the examination of the remainder of

FIG. 431.—BLASTOMYCOTIC ULCERATIONS ON DORSAL SURFACE OF LOWER THIRD OF LEG.
Note the peculiar warty or papillomatous elevations characteristic of this variety of ulcer, and the raised edges showing multiple areas of softening or miliary abscesses in which the organisms are most frequently found.

the body reveals evidences of syphilis in the form of sharp-cut, round or reniform scars covered with parchment-like fine skin. The therapeutic test is, unfortunately, not an absolutely infallible one, since many varicose and other slowly healing ulcers were greatly improved through the stimulating influence of antisyphilitic remedies.

FIG. 432.—MICROPHOTOGRAPH SHOWING BLASTOMYCOTIC ORGANISMS IN SPUTUM FROM PATIENT SHOWN IN FIG. 431. (× 1200.)

4. *Trophic Ulcers.*—These are the result of some disease of the peripheral or central nervous system. They usually occur on the sole of the foot (especially in tabetic patients), over the head of the first metatarsal bone. Rarely they are found upon the hand. They present a round, punched-out appearance, and involve the deeper structures of the foot, including the bones. In every such case, an examination of the central nervous system should be made

for evidence of disease of the spinal cord, such as tabes or syringomyelia. The condition has also been called *mal perforans pedis*. It may be simulated by an ulceration due to necrosis of skin over an infected bursa in the same location, with suppuration and ulceration of the overlying skin.

5. *Blastomycotic Ulcers.*—These may occur either on the upper or lower extremities, but more often on the latter (Fig. 431). Their presence must be suspected if (*a*) all of the forms of ulcer just described have been excluded, and (*b*) from the appearance, viz., a peculiar warty or papillomatous surface, especially around the edges; (*c*) from the history of contact with horse manure, etc., and (*d*) from finding the characteristic yeast organisms (Fig. 432) in the

FIG. 433.—TUBERCULOSIS OF THE SKIN OF THE LEFT UPPER EXTREMITY.

1, Indicates primary focus or atrium of infection from a tuberculous steer; 2, both of the figures 2 are placed upon several of the many secondary tuberculous foci along the course of the lymph-vessels; 3, tuberculous axillary glands.

secretion or in the miliary abscesses of the edge. A number of cases have been reported during recent years of systemic infection with blastomyces, of which the cutaneous ulcers were only a part of the clinical picture. One should always remember the possibility of such general infections.

6. *Tuberculous Ulcers.*—These are quite rare on the skin of the extremities except when associated with a similar affection of the deeper structures. They can be recognized by the characteristic thin bluish edges, by the undermined condition of the latter, by the caseous degeneration of many of the granulations covering its surface, and the presence of enlarged regional lymph-nodes.

In some cases of infection with virus from cattle, etc., the process may

FIG. 434.—SENILE GANGRENE.
Note sharp line of demarcation.

begin as an ulcer on the fingers and spread along the lymph-vessels to the groin or axilla, causing multiple ulcerations with undermined, thin, bluish edges and cheesy surface (Fig. 433).

In some forms of cutaneous tuberculosis the ulceration is not marked, but instead of it one finds a condition similar to that mentioned in the blastomycotic ulcers, viz., papillomatous excrescences. The latter, however, are higher and more apt to be undermined in tuberculosis. This is the form commonly known as the verrucous or warty variety of cutaneous tuberculosis.

7. *Decubital Ulcers.*—These may be recognized from their appearance at places which are subjected to pressure, such as the heel, the extensor surfaces of the toes, the malleoli, amputation stumps, great trochanter, and tuberosity of the ischium. The cause should always be

FIG. 435.—BED-SORES IN A CASE OF FRACTURE OF THE SPINE ("International Text-Book of Surgery").

searched for, viz., a tight or ill-fitting shoe, disease of the spinal cord or peripheral nerves, or cachexia, due to various constitutional causes, such as diabetes, arteriosclerosis, anemia, etc.

Gangrene.—Gangrene occurs far more frequently in the lower than in the upper extremities. In the diagnosis of gangrene, one must consider not only the clinical phenomena, but also the etiology of the process. The mode of onset of gangrene varies somewhat, according to the cause. In the forms known as senile and pre-senile gangrene, the actual necrosis is preceded by more or less severe pain for a considerable period before any discoloration, etc., of the limb takes place. In the gangrene due to Raynaud's disease the process is also preceded for a long time by a bluish tinge of the fingers or toes, which may or may not be followed by actual gangrene.

Gangrene may involve one or more toes or fingers, or an entire limb. It may at other times appear as single or multiple patches. In the majority of forms of gangrene, the direct cause is a cutting-off of the blood-supply. The result is the same, whether the anemia be due to an obstruction to the flow of arterial blood or injury to the artery or some infective process or injury to the vein which prevents the return of the venous blood of the limb. In a relatively small proportion of cases, the gangrene is due to infection with the organisms described on page 613, viz., the bacillus of malignant edema or bacillus aërogenes capsulatus of Welch.

FIG. 436.—SOLES OF FEET IN RAYNAUD'S DISEASE.
The bluish-black discoloration of beginning gangrene is more marked upon the right than upon the left foot.

If the dead tissue remains dry, we speak of a *dry gangrene or mummification.* If it becomes moist, the process is termed *moist gangrene* or sphacelus. In both forms, putrefaction may occur, so that there is a marked fetid odor accompanied by signs of toxemia from absorption of the septic products. Clinically, it is useless to retain the terms dry and moist gangrene, since one may pass into the other and the same cause may at one time produce one form and at another time the other variety, the difference in this mode of action being more one of infection or absence of infection by putrefactive organisms.

FIG. 437.—SIDE VIEW OF FEET OF PATIENT SUFFERING FROM RAYNAUD'S DISEASE.
The bluish-black discoloration is far more advanced upon the right than upon the left foot.

FIG. 438.—GANGRENE OF THE TOES AS THE RESULT OF ADVANCED RAYNAUD'S DISEASE.

Note the cyanotic hue of the distal portion of the dorsum of the foot and of the remaining toes. The gangrene is far advanced on the fourth toe and just beginning on the third.

The diagnosis of the presence of gangrene itself usually presents no difficulties. The part may become, either gradually or suddenly, cold and bluish. Pressure with the finger over the discolored area shows a very slow return of color. This bluish discoloration is gradually replaced by a black or green hue. The changes in color may be limited to the area originally involved, or the process gradually spreads. In every form of gangrene, except those due to infection of wounds with gangrene-producing organisms (bacillus of malignant edema and bacillus aërogenes capsulatus), a line of demarcation forms, separating the dead from the living tissues. Accompanying the above local changes one finds in some of the forms, especially in those due to obstruction or to injury of the artery of the limb, an absence of pulsation in the vessel at the points where it it is normally to be felt.

FIG. 130.—ENORMOUS ELEPHANTIASIS OF BOTH LOWER EXTREMITIES. (Dr. W. A. Evan's case.)

The constitutional disturbances vary greatly. In some, they are very marked, while in others they are slight.

When present, they are due to septic intoxication or to septicemia, and have been fully described on pages 615 and 616.

After a diagnosis of the existence of gangrene has been made, the next question is to determine its cause. By a process of exclusion one must rule out one after the other of the following forms, viz.: (*a*) Senile and presenile; (*b*) diabetic; (*c*) injury to arteries and veins; (*d*) freezing; (*e*) embolism; (*f*) gangrene following one of the infectious diseases; (*g*) symmetrical gangrene or Raynaud's disease; (*h*) so-called idiopathic multiple gangrene; (*i*) ergotism; (*j*) carbolic acid gangrene.

The principal diagnostic points of these different forms of gangrene are as follows:

(*a*) *Senile Gangrene.*—This may occur after a slight injury, and is often preceded by severe pains in the limb, or a feeling of numbness. In other cases there are no premonitory signs, and the first warning is the appearance of a gangrenous spot on one toe or on the dorsum. Senile gangrene is invariably a disease of the lower extremities, and seldom extends higher than the middle of the leg. The absence of pulsation in the dorsalis pedis, posterior tibial, popliteal, and femoral arteries is a prominent symptom. It may involve one or both limbs (Fig. 438).

FIG. 440.—GENERAL KELOIDAL DISEASE IN A NEGRO, WITH MOLLUSCUM FIBROSUM (Matas).

Pre-senile Gangrene.—This occurs in middle-aged or even young persons. All writers agree that the cause is the result of changes in the intima with occlusion of the vessel, in the same manner as in the true senile form. The predisposing causes are tobacco, alcohol, syphilis, trauma, and diabetes. The gangrene is often preceded by a group of symptoms termed *intermittent claudication*, first described by Charcot, in 1859. The patients complain of stiffness and pain in the calf of the leg on walking, so that they limp. The foot and leg show extreme pallor on walking. In some cases an ulcer may appear on the toes, which gradually increases in size, and is very painful. There is no pulsation in the arteries at an early stage.

(*b*) *Diabetic Gangrene.*—There are two distinct forms, the inflammatory and non-inflammatory, as is the case in senile gangrene. In the inflammatory form there is considerable edema, tenderness and febrile reaction, with gradual spreading of the gangrene. In the non-inflamma-

tory form, the process is slower and there is a mummification. Both varieties of diabetic gangrene are due, not to the diabetes itself, but, in the majority of cases, to the coexisting arteriosclerosis. The diagnosis, therefore, of this form can only be made by examining the urine for the presence of sugar.

(*c*) *Gangrene from Injury to the Arteries or Veins of a Limb.*—Attention has been called to this form of gangrene on page 506. The diagnosis of this form can be made if the changes in the color of a limb, accompanied by absence of pulsation in its palpable arteries, follow within a few hours to several days after an injury. It is especially frequent after supracondyloid fractures of the femur, or separation of the lower epiphysis, and also after severe crushing injuries of the upper or lower extremities.

FIG. 441.—ANTERIOR VIEW OF SAME PATIENT SHOWN IN FIG. 442.

Note the many pedunculated fibromata.

FIG. 442.—POSTERIOR VIEW OF MARKED CASE OF MULTIPLE FIBROMA MOLLUSCUM.

(*d*) *Gangrene from Freezing.*—This cause can be readily recognized from the history, although the possibility of this variety occurring in a person suffering from arteriosclerosis or diabetes must not be forgotten.

(*e*) *Embolic Gangrene.*—This form is due to the blocking of the lumen of one of the larger arteries, such as the brachial, femoral, or popliteal. It occurs in elderly persons as the result of an endocarditis. The gangrene of the limb occurs far more rapidly than in

the senile form, and can only be distinguished from it by its sudden onset and the presence of evidences of valvular heart disease or of arteriosclerosis.

(*f*) *Gangrene in the Course of the Infectious Diseases.*—It is most often due to an infective process in the artery with or without accompanying venous thrombosis. It occurs in typhoid, typhus, puerperal infection, measles, scarlatina, pneumonia, malaria, and acute articular rheumatism. Of all of these, those complicating typhoid constitute the majority (forty-four of sixty-eight cases, collected by Barraud[1]). The clinical signs are the same as those of other forms of gangrene. The diagnosis can be made from the gangrene, absence of pulsation, and the history of the preceding infectious disease.

FIG. 443.—POSTERIOR VIEW OF A CASE OF DIFFUSE MULTIPLE CUTANEOUS FIBROMATA. (See text.)

(*g*) *Gangrene due to Raynaud's Disease.*—This form can be recognized from the history of a bluish discoloration of either the fingers or toes, or both, accompanied by severe pain for years before the onset of the gangrene. The latter is characterized by its symmetrical distribution (Fig. 436). The bluish or asphyctic hue is often very marked in the adjacent skin or toes. The disease may not be confined to the extremities, but involve symmetrical areas on the trunk.

Of the other forms of gangrene, the diagnosis of those due to carbolic acid or ergotism can only be made from the history of the use of these drugs. Gangrene due to ergotism is very rare, and the gangrene resulting from the application of even weak solutions of carbolic acid is in-

[1] "Deutsche Zeitschrift f. Chirurgie," vol. lxxiv.

frequent, since the latter is seldom used as a wet dressing at the present time.

The diagnosis of idiopathic multiple gangrene should only be made if all of the above-named causes of gangrene have been carefully excluded. Many case of gangrene without any obvious cause have been reported in young or middle-aged persons.

SURGICAL DISEASES OF THE SKIN.

Elephantiasis.—This chronic diffuse hypertrophy of the skin has already been referred to as a complication of extensive ulcers of the leg, especially those of the traumatic variety. It causes enormous enlargement of the foot and leg, or of the entire limb. At times both lower extremities are involved (Fig. 439).

FIG. 444.—SEBACEOUS CYST IN POPLITEAL SPACE, RESEMBLING DISTENDED SEMIMEMBRANOSUS BURSA.

The limb is enormously swollen, is very firm, of a grayish color, and covered, especially around the ankle and upon the foot, by innumerable pigmented papillary excrescences. In places deep furrows are seen interrupting the swelling. It is a disease due to pathologic changes in the lymph-vessels of the skin, consisting of great thickening of their walls and cystic dilatation of the vessels themselves.

It is of interest, from a diagnostic point of view, to search for the cause. In some cases occurring in tropical climates, it is due to the filaria sanguinis hominis, which obstructs the lymph-vessels. In our own northern climate, the disease may be due (*a*) to interference with return circulation through ulcers which almost encircle the limb; (*b*) to chronic inflammatory processes, such as eczema. Local or general elephantiasis may also follow removal of the regional lymph-nodes, but this form is quite rare.

In persons suffering from this condition there are attacks of acute inflammation of the thickened area from time to time, quite analogous to the recurrent attacks of inflammation already referred to as occurring

in lymphangiomata (see page 144). The limb becomes reddened, very tender, and feels hot. The swelling is increased, and these symptoms are accompanied by a rise in temperature. Such attacks last from a few days to weeks, and then the symptoms disappear.

Keloid.—This is a peculiar tumor-like formation of the skin, which either develops in the scar of some wound or arises spontaneously. In the former case, it is most apt to occur in those persons having a history of tuberculosis, especially in the negro race. They may be limited to a scar, or may grow quite diffusely. The spontaneous form is rare, and does not appear on the extremities. The favorite locations are over the sternum and front of the shoulders (Fig. 440). In both traumatic and spontaneous varieties, the appearance and slow growth are the same.

The keloid feels firmer than the surrounding skin, above whose level it rises slightly. It is of a dull reddish color, and extends over the entire length of the scar, even involving the cicatrices following the suture openings in the skin.

Tumors of the Skin and Subcutaneous Tissue.—The diagnosis of tumors of the skin does not differ from that of similar conditions elsewhere.

The various forms of tumors which occur in the skin of the extremities are:

Benign.	Malignant.
1. Hemangioma (capillary and venous).	1. Sarcoma:
2. Lymphangioma.	(*a*) Spindle- and round-celled.
3. Fibroma (soft and hard).	(*b*) Hemangiosarcoma.
4. Lipoma.	(*c*) Lymphangiosarcoma.
5. Benign epithelial wart (papilloma).	(*d*) Mycosis fungoides.
6. Moles (congenital and acquired).	2. Carcinoma:
7. Sebaceous and dermoid cysts.	(*a*) Malignant warts.
8. Adenoma of sebaceous or sweat glands.	(*b*) Rodent ulcers.
	(*c*) Epithelioma proper.
	(*d*) Adenocarcinoma arising in the sweat and sebaceous glands.

In attempting to make a diagnosis, the following points must be considered: (*a*) The question of whether the tumor has grown slowly or rapidly; (*b*) the period when first noticed, whether at birth, before middle age, or after the latter period; (*c*) the clinical appearances; (*d*) evidences of metastases, and, lastly, (*e*) the results of the microscopic examination.

Of the above tumors, the majority of those in the benign group require no special description here.

Hemangioma and *lymphangioma* are most often found in children, and may involve an entire limb. This is especially true of the upper ex-

tremity. The diagnostic features have been described on pages 188 and 189. The *soft fibroma* is usually a part of a generalized condition, but may occur single, as small, soft, pedunculated growths (see Fig. 442). The hard variety must be distinguished from keloids. It is smooth and hard, may become pedunculated, and appears independently of scars.

Adenomata of the sweat and sebaceous glands are found chiefly in the axilla as a hard, round nodule, lying just beneath the skin. They may also occur upon the sides of the nose as soft tumors which not infrequently undergo malignant changes.

Sebaceous and *dermoid cysts* are quite rare in the extremities, but the former may be encountered in unexpected locations (see Fig. 444). They lie just beneath the skin, which is freely movable over them, unless they have become adherent to it.

FIG. 445.—CAVERNOUS HEMANGIOMA OF OUTER ASPECT OF RIGHT GLUTEAL REGION (Greensfelder).

In addition to the ordinary *papillary wart* often found on the hands and feet, a fibro-papillary hypertrophy may occur, which at first may resemble an epithelioma, but is softer and slower in growth. The appearance of *moles* does not differ from that of the same growths elsewhere. They may show a tendency to become malignant by ulceration, especially in later life, and more often in those having a smooth than a warty surface.

Malignant Tumors.—Of these, the spindle- and round-celled *sarcomata* quite rarely arise from the connective tissue of old scars. More often they have their origin in the fasciæ between the skin and muscles. They grow very rapidly, as a rule, especially the round-celled variety, and lift up the overlying skin.

The *hemangiosarcomata* belong to the peritheliomata, and represent a malignant change in a previously existing hemangioma. Often the case is seen when a history of such a preceding angioma cannot be

obtained, and the diagnosis of its nature is impossible without microscopic examination.

The *lymphangiosarcomata* represent a malignant change either in a preëxisting lymphangioma or in a congenital mole.

The *malignant tumors of the epithelial type* are not difficult to diagnose. They all show an indurated base and adhesions to the underlying structures. The *ordinary type of epithelioma* usually develops in old ulcers, the result of varicose veins, or in those due to former trauma or to burns. Such a malignant change can be recognized by the steady growth of the ulcer, and the marked induration of its base and edges. An epithelioma may rarely occur as a primary tumor in the skin without previous ulceration (Figs. 149 and 150).

FIG. 446.—SARCOMA OF DORSUM OF FOOT.
The black area at its upper level was an area of ulceration covered with granulation tissue.

Rodent ulcers occasionally develop in the skin of the extremities. They grow very slowly, and do not produce metastases in the regional lymph-nodes, as do the other forms of superficial carcinomata. *Adenocarcinomata of the sweat or sebaceous glands* are both very rare tumors in the extremities, and would be most likely to occur in the axilla or groin.

DISEASES OF THE ARTERIES.

The most frequent surgical diseases of the arteries are inflammations of the vessel wall (arteritis) and aneurysms.

An arteritis is always secondary to some infective focus elsewhere. If a septic embolus lodges in an artery it causes a suppurative inflammation of the wall of the vessel and the formation of an abscess around the artery. In the case shown in Fig. 426 such an infection followed suddenly, after the onset of gangrene of the lung, the embolus lodging in the brachial artery. A diagnosis can only be made from the history of the existence of a septic focus elsewhere, followed by the sudden appearance of evidences of infection around an artery of the extremities.

ANEURYSMS.

Cirsoid Aneurysms.—In connection with diseases of the scalp it was stated that the majority of cirsoid aneurysms occur in the frontal and temporal arteries. They have also been observed in the hands and fingers, being more common in women than in men in the proportion of ten female to six male in the sixteen cases collected by Wagner.[1] The diagnosis presents no difficulty. The tumor is soft, compressible, and pulsates, and one can feel distinctly the outline of the vessels composing it.

FIG. 447.—EPITHELIOMA OF INNER ASPECT OF RIGHT THIGH IN A WOMAN OF FIFTY-FIVE.

On auscultation, one hears a soft-blowing intermittent murmur. Its differentiation from an angioma of the venous type and from an arteriovenous aneurysm has been discussed on page 75.

Non-traumatic Aneurysms of the Larger Vessels of the Extremities.—The fact that an aneurysm may follow a blow upon an artery or a penetrating wound of the vessel, with rupture of its coats, has already been referred to. True aneurysms not infrequently occur in the larger arteries of the upper and lower extremities, being due to atheromatous changes in the vessel wall. In such patients, the history of

[1] Beiträge zur klinischen Chirurgie, vol. xi, p. 49.

a preceding syphilis, of abuse of alcohol, of gout, or diabetes is usually to be obtained.

There is no longer any question that trauma plays a certain rôle in these cases, since they most often occur in men who are obliged to do hard work. Under these conditions pathologic arteries are more likely to form an aneurysm.

Of a total of five hundred and ninety-one aneurysms collected by Crisp, three hundred and eight were found in the arteries of the extremities. These involved the popliteal artery in one hundred and thirty-seven cases and the femoral in sixty-six, so that it may be said that aneurysms affect these two vessels more frequently than any of the others of the extremities. The axillary (sixteen cases) and brachial (one case) and the smaller vessels of the forearm and leg are rarely affected.

FIG. 448.—POPLITEAL ANEURYSM.

The arrow points to the prominence over the middle of the popliteal space due to the aneurysmal sac. Note the dilated and varicose condition of the superficial veins on the outer aspect of the same limb.

Traumatic Aneurysm.—The diagnosis of a traumatic aneurysm does not differ from that of the non-traumatic already given except in these two points: (*a*) There is usually no history of a single injury in the non-traumatic forms, although there may be that of repeated ones, and (*b*) the swelling itself is more apt to be circumscribed. The tumor is usually to be outlined distinctly; it is ovoid, round, or spindle-shaped. The characteristic signs of aneurysms are: (*a*) A pulsation which is expansile in character and can be best felt by grasping the tumor between the thumb and index-finger (see Fig. 451). This pulsation is synchronous with that of the pulse at the wrist or some other superficial artery. (*b*) A distinct blowing murmur is to be heard with the stethoscope which is also synchronous with the pulse. The tumor itself can be felt in the majority of cases to

be directly connected with the artery involved and a peculiar thrill is felt with every pulsation. Pressure upon the vessel on the proximal side of the aneurysm causes both the pulsation and murmur to be diminished or even disappear.

An aneurysm can be differentiated from pulsating neoplasms, especially osteosarcomata. The latter grow more rapidly and feel harder than an aneurysm, and the pulsation is more diffuse, and not expansile, but has a more lifting character.

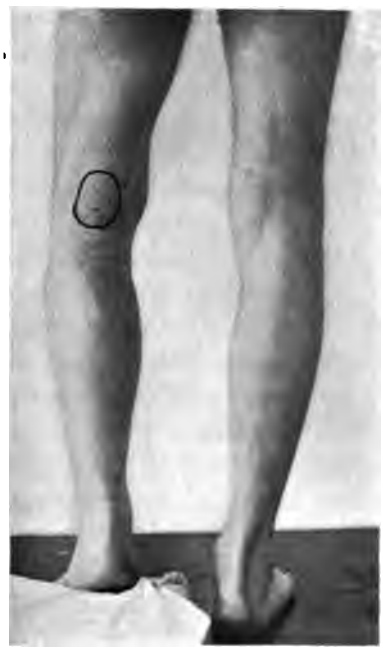


FIG. 449.—POSTERIOR VIEW OF A CASE OF NON-TRAUMATIC POPLITEAL ANEURYSM, SHOWING LOCATION (BLACK CIRCLE) OF PROMINENCE AT BACK OF KNEE.

FIG. 450.—LATERAL VIEW OF NON-TRAUMATIC POPLITEAL ANEURYSM.

The black arrow points to the prominence at the back of the left knee. Same case shown in Fig. 449.

Aneurysms of the femoral artery can be differentiated from a femoral hernia or a psoas abscess by the absence, in both of the latter, of expansile pulsation and a murmur, and furthermore by the fact that the tumor in the case of a femoral hernia or psoas abscess can usually be reduced. In the case of a psoas abscess the swelling shows more distinct fluctuation, and there are evidences of spinal disease.

If an aneurysm begins to show evidences of infection with involvement of the surrounding tissues the diagnosis becomes very difficult. There is high fever present, the swelling does not pulsate, and there are

all the local evidences of a phlegmon. In a case occurring in the service of one of my colleagues an aneurysm of the femoral artery ruptured spontaneously and the patient succumbed to the hemorrhage, some hours after incision was made in the infected area, the diagnosis being a deep infection of the thigh. In case of doubt it is always best to observe the case a few days before making a diagnosis.

DISEASES OF THE VEINS.

Phlebitis and Thrombosis.—Inflammation of a vein involves all of the coats of the vessel and the tissues immediately surrounding it. The disease occurs in an acute and subacute form. The acute form can be recognized by the presence of marked redness of the skin over the vein, great tenderness on pressure, and swelling of the soft tissues around the vein. The outline of the vein itself can be felt as an extremely tender cord, especially if a superficial vein like the internal saphenous is involved. Accompanying these local phenomena there is high fever, prostration, and rapid pulse. If septic emboli become detached and float into the circulation, a pyemia results (page 617). Such virulent cases are fortunately rare.

FIG. 451.—ANTERIOR VIEW OF EXTERNAL ILIAC (1) AND FEMORAL (2) ANEURYSMS, SHOWING METHOD OF PALPATION OF AN ANEURYSMAL SAC FOR EXPANSILE PULSATION.

In the majority of cases of phlebitis, the disease runs a subacute or chronic course. The chief diagnostic points are (*a*) the presence of pain and tenderness along the course of the vein; (*b*) edema of the limb below the point of thrombosis, if the thrombosis involves the deeper veins; (*c*) if the vein is a superficial one, it can be felt as a tender firm cord. If the condition occurs as a complication of varicose veins, the latter become very tender and hard, the thrombi occupying every portion of the varicosities. The skin over them is red and exceedingly sensitive to the

touch. A subacute phlebitis is apt to follow (*a*) an infection of the soft parts of an extremity; (*b*) any one of the acute general infections, such as typhoid, pneumonia, rheumatism, or (*c*) occur in alcholism, or (*d*) as a phlegmasia alba dolens in puerperal infection.

Even if the inflammatory symptoms disappear, the edema of the extremity may persist for months to years.

A not infrequent complication of a thrombophlebitis of the deeper veins of the lower extremity is the appearance of ulcers (page 641) which are very resistant toward treatment.

Thrombophlebitis may occur after operations and show no clinical signs except a slight local tenderness. Even the latter may be absent, and the first symptom may be the onset of symptoms of pulmonary embolism described as a post-operative complication on page 794.

FIG. 452.—VARICOSE VEINS ("International Text-Book of Surgery").

Varicose Veins.—This condition is almost exclusively confined to the lower extremities, although it also occurs in the veins of the spermatic plexus as a varicocele. It affects chiefly the internal saphenous vein; less often the external saphenous vein.

In the majority of cases, varicose veins cause no symptoms until complications appear. In a small percentage of cases attention is first called to their presence by the occurrence of pain referred along the line of the vein. If uncomplicated, the varicose veins can be felt as soft tortuous cords. The skin over them is stretched so that the bluish color of the vessel shows through. At times, the most prominent mass is found over the internal condyle of the femur. The individual dilatations may be large enough to simulate cystic tumors or other conditions. This tumor like dilatation is especially seen near the saphenous opening in Scarpa's triangle. The soft dilatation of such a varicosity of the internal saphenous at Scarpa's triangle may resemble a femoral hernia (see page [illegible]) or a psoas abscess. One of

methods of determining the extent of the varicosities is to compress the main trunk of the internal saphenous vein at the middle of the thigh. The *chief complications* of varicose veins are (1) ulceration; (2) subacute phlebitis, with the formation of thrombi and phleboliths; (3) hemorrhage from rupture of a varicosity; (4) chronic eczema and pigmentation of the limb, with the development of an elephantiasis. *Vari-*

FIG. 453.—METHOD OF PALPATING THE AXILLARY LYMPH-NODES.

The same method may be used in both sexes. The patient's arm is laid upon the examining arm of the surgeon, after the fingers of the latter have been passed along the thoracic wall to the apex of the axilla. In this manner the axillary fascia is relaxed and the examining fingers can be inserted much higher than by any other method.

cosities of the deeper veins can be recognized (*a*) by the presence of edema around the ankle without other ascertainable cause; (*b*) the dilatation of the finer veins of the dorsum of the foot.

DISEASES OF THE LYMPH-VESSELS.

Acute lymphangitis has been referred to in connection with infection of the extremities (see page 612). Its presence can be recognized by the

occurrence of a red streak in the skin, leading from the seat of infection to the axilla or groin, as the case may be. The inflamed lymph-vessel can also be palpated as a firm, tender cord, lying just beneath the skin. Abscesses may form in the course of the vessel opposite its valves.

Chronic lymphangitis occurs in the extremities chiefly in a tuberculous form (Fig. 433). The atrium of infection may be on the hand or

FIG. 454.—METHOD OF PALPATING THE CUBITAL LYMPH-NODES.

The examiner should stand in front of and to the right or left of the patient, according to the side to be examined, and grasp the elbow in such a manner that the tips of the fingers rest upon the humerus just above the internal condyle. The nodes are to be felt between the inner edge of the biceps and the space just above the internal condyle of the humerus.

foot. The lymph-vessel itself feels hard and nodular, and may break down opposite the valves into multiple foci of suppuration with the formation of typical tuberculous ulcers. Such an infection may come from bovine tuberculosis, as in the case shown in Fig. 433.

Lymph Cysts.—These are quite rare, arising as the result of the obstruction of a lymph-vessel through trauma and occurring most frequently

FIG. 455.—LYMPHATIC SUPPLY OF VARIOUS REGIONS (DIAGRAMMATIC).

1, Lymphatic current from lower limb to lymph-nodes over Scarpa's triangle (S). In some cases infection extends beyond these to the deep iliac nodes (DI) lying along the external iliac vessels. 2, Current from external genitalia and rectum to lymph-nodes (P) lying over and above Poupart's ligament. If the infection or carcinomatous involvement extends beyond these, it next invades the deep iliac and then the lumbar (L) lymph-nodes. Occasionally infection from the external genitals does not involve the nodes over Poupart's ligament, but invades the nodes below Poupart's ligament, *i. e.*, over Scarpa's triangle (S). 4, Current from inner side of forearm to cubital nodes (C), and from these to axillary nodes (Ax). 5, Current from outer side and back of fingers, hand, and forearm direct to axillary nodes. 6, Current from lip to submaxillary nodes. 7, Current from tongue, inner side of cheek, tonsils, ear, and naso-pharynx to deep cervical nodes. 8, Current from scalp and parotid region to deep cervical nodes.

in the thigh as large cystic tumors whose origin is usually not recognized until operated upon. They present themselves as cystic tumors in the groin or thigh which must be differentiated from a hydrocele of the canal of Nuck, from lipoma, from blood-cysts, and from tuberculous abscesses.

DISEASES OF THE LYMPH-NODES.

This subject has been fully discussed in the chapter on the neck (page 175). The lymph-nodes of the extremities, which are most frequently involved, are the cubital, axillary, and superficial and deep inguinal nodes. The diagnosis of an *acute inflammation* presents no difficulties. The nodes can be felt as round tender tumors, which later become matted together and show evidences of suppuration, such as superficial redness and fluctuation. It is of great importance to remember that the primary focus of infection may have healed and perhaps have been forgotten, when the patient presents himself with all of the evidences of acute inflammation of the cubital, axillary, and inguinal nodes. This clinical fact is especially to be found in children. Suppuration of the inguinal nodes most frequently follows gonorrhea, soft chancroids or an infection of the skin of the toes or legs.

Chronic Inflammation of the Lymph-nodes.—As was found to be the case in the neck, the percentage of tuberculous inflammation of the lymph-nodes is far greater than that from any other cause. Tuberculosis of the inguinal nodes is quite rare,

while that of the axillary nodes is a frequent complication of the same affection of the neck.

When enlarged nodes are found in the axilla, the groin, or the cubital region, one must exclude one by one the following forms of enlargement of the lymph-nodes, by the diagnostic landmarks mentioned on pages 175 to 181: (*a*) Tuberculosis; (*b*) syphilis; (*c*) simple chronic hyperplasia as the result of long-continued irritation; (*d*) lymphosarcoma; (*e*) lymphatic leukemia; (*f*) Hodgkin's disease; (*g*) secondary carcinomatous en-

FIG. 450.—METHOD OF PALPATING INGUINAL LYMPH NODES.

The examining hand is placed flat upon the anterior aspect of the thigh, the finger tips resting on Poupart's ligament, or rather the skin overlying it, and the nodes thus palpated by a rolling motion of the finger-tips. The deep iliac nodes can be palpated when enlarged as the result of infection by inserting the fingers deeply above Poupart's ligament.

largement. In connection with the last named it is important to call attention to the fact that quite malignant tumors of the breast cause early enlargement of the axillary nodes. Carcinoma of the prostate or of the lowermost portions of the rectum and vagina may cause enlargement of the inguinal nodes at an early date. If one find enlarged and hard inguinal nodes in an elderly person a search for such a primary cancer should always be made.

DISEASES OF THE BURSÆ.

In order to be able to make a diagnosis one must recall the location of the more important bursæ. These are (*a*) the subdeltoid, lying beneath the deltoid muscle; (*b*) the olecranon; (*c*) the metacarpo-phalangeal; (*d*) the ischial, over the tuberosity of the ischium; (*e*) the trochanteric, over the greater trochanter; (*f*) the prepatellar; (*g*) one between the tendo Achillis and the os calcis; (*h*) the ileopsoas bursa; (*i*) one over the head of the metatarsal bone of the great toe; (*j*) the semimembranous bursa (Fig. 444).

Acute bursitis as the result of trauma has already been referred to. A similar condition may follow infection of the neighboring or even distant parts. Such an acute inflammation has been repeatedly observed in gonorrhea, involving most frequently the achillean and prepatellar bursæ. Acute bursitis, whatever the cause may be, can be recognized when a tender swelling appears at a point corresponding to one of the above normal bursal locations. The skin over the inflamed bursa may be red and infiltrated. The direct relation of the subdeltoid and ileopsoas bursæ to the shoulder- and hip-joints respectively is of great surgical importance in acute inflammations of these bursæ, owing to the frequency of secondary joint involvement.

Chronic Bursitis.—In these there is a painless tumor, often as large as a hen's egg, showing distinct fluctuation corresponding to the various normal positions of the bursæ. The majority of these tumors are the result of chronic irritation, with resultant catarrhal inflammation of the serous lining of the bursa and the production of a variable quantity of fluid. The latter often contains many small rice bodies. The diagnosis presents no difficulty unless suppuration has occurred and a sinus formed. The condition under these circumstances greatly resembles that of a sinus leading to an old focus of osteomyelitis. A chronic enlargement of the olecranon bursa has been given the name "miner's elbow," while that of the prepatellar bursa is called "housemaid's knee," although both often occur independently of these occupations.

Tuberculous and syphilitic bursitis occur less frequently than the ordinary catarrhal variety. A diagnosis of a tuberculous bursitis can only be made before operation, if a swelling which shows distinct crepitation (from the presence of many rice bodies) appears over one of the usual bursal locations. Syphilis causes a gummatous infiltration of the wall giving rise to a thick indurated mass at the location of a bursa.

Subacromial Bursitis.—E. A. Codman has recently[1] directed attention to a lesion of the subdeltoid or, more properly speaking, subacromial bursa, which explains many of the symptoms following injuries of the shoulder. Subacromial bursitis has been frequently described before Codman's paper, but the importance of this affection has never been fully appreciated. The following three types of inflammation are more or less clearly defined: (1) An acute or spasmodic type; (2) a subacute or adherent type; and (3) a chronic or nonadherent type.

FIG. 457.—SHOWING THE CHARACTERISTIC ATTITUDE OF A PATIENT WITH SUBACROMIAL ADHESIONS OR SCAPULO-HUMERAL SPASM WHEN ENDEAVORING TO ABDUCT BOTH ARMS (Codman).

Abduction on the affected side is mainly accomplished by rotation of the scapula on the chest wall. The angle between the axis of the humerus and the spine of the scapula is practically the same as if the arm were at the side. Notice that on the normal side the axis of the humerus is parallel with the spine of the scapula, while on the affected side it is at right angles to it. On both shoulders the scapula is abducted to its full extent.

Symptoms of the Acute or Spasmodic Type.—1. Localized tenderness on the point of the shoulder, just below the acromion process and to the outer side of the bicipital groove.

2. When attempts at abduction or external rotation are made, the scapula after a certain point is locked by spasm and moves with the humerus (Fig. 457).

3. Pain is felt either in the region of the point of the shoulder or down the outer side of the arm, even extending into the hand. The patient frequently thinks the trouble is at the insertion of the deltoid; sometimes pain at this point is the only symptom.

4. Occasionally effusion in the bursa is demonstrable, and frequently there is puffiness to the touch.

Symptoms of Type II, the subacute or adherent form: In this type

[1] "Boston Medical and Surgical Journal," vol. clix, Nos. 17, 18, 19, 20, and 21, 1908. The author is indebted to Dr. Codman for permission to use one of his illustrations and many valuable points from his article.

actual adhesion exists between the roof and floor of the bursa and there is an absolute mechanical limitation to abduction and external rotation. There may or may not be active inflammation as well.

1. In this type localized tenderness may or may not be present, according to the degree of existing inflammation. In recent cases it is usually present; in old quiescent cases, absent.

2. Abduction and external rotation of the humerus on the scapula are limited to a greater or less extent, usually so much that the tuberosity will not pass beneath the acromion.

3. The pain is in the same distribution as in Type I, and frequently in the neck also, and in the severe cases it closely resembles brachial neuritis.

Symptoms of Type III, the chronic form: In this type the essential characteristic is painful motion, but the full arc of motion persists.

1. Localized tenderness may or may not be present; it is often absent.

2. Abduction and external rotation are but little, if any, limited, but at some point during abduction acute tenderness is experienced, which disappears as soon as the tuberosity is safely beneath the acromion. In lowering the arm this sensation is again experienced. The patient usually winces, but the pain cannot be called severe.

3. The scapula does not accompany the motions of the humerus, but, as said above, the relative motions may be jerky and uneven.

4. There may be considerable pain, especially after use; it is sometimes severe enough to interfere seriously with sleep. The pain is often felt at the insertion of the deltoid or in the neck, as in the other types. Rupture of the supraspinatus tendon or separation of its facets of insertion is a common cause of subacromial bursitis.

Differential Diagnosis.—*Tuberculosis.*—The early stages of tuberculosis of the head of the humerus are very difficult to differentiate. *x*-Ray appearance in tuberculous invasion is characteristic, and in subdeltoid bursitis is normal. The atrophy of the muscles and the fixation are more pronounced in tuberculosis.

Fractures of the tuberosity and of the anatomical and surgical neck might be confused, but the *x*-ray here also gives a crucial test. We must not forget that subdeltoid adhesions are a frequent late complication of such fractures.

Circumflex Paralysis.—Before we came to make careful diagnoses of pathologic conditions of the shoulder, many cases were classed as circumflex paralysis. It may be at once recognized, if present, by the absence of the contraction of the fibers of the deltoid when the effort to raise the arm is made.

Brachial Neuritis.—Of all the conditions which are difficult to differ-

entiate, brachial neuritis is, perhaps, the most difficult. Most cases are due primarily to a lesion of the bursa. In the acute cases, and the adherent cases without pain, there is no difficulty, but in the adherent cases where there is still active inflammation and extreme pain, the diagnosis is very difficult. Subdeltoid bursitis is the most common cause of brachial neuritis. The pain is not felt definitely on the known anatomical courses of the branches of the brachial plexus. There is seldom any considerable degree of tenderness on the nerve-trunks, and, on the other hand, the diffuse tenderness is usually on the hands of intermuscular fascia rather than the nerve-trunks. In chronic cases, where the motions of the bursa are very painful at certain points, those points correspond with the degree of motion at which the tuberosity comes closest to the acromion; that is, when an angle of 130 degrees between the shaft of the humerus and the spine of the scapula is reached.

DISEASES OF THE TENDONS AND TENDON-SHEATHS.

Inflammatory Affections.

These almost invariably involve both the tendon itself and the tendon-sheath. The condition may be either primary or secondary. It may also be acute or chronic.

Acute Primary Tenovaginitis or Tenosynovitis.—(*a*) *Tenovaginitis Crepitans.*—This occurs only in the extensor sheaths of the thumb after excessive use or exposure to cold. It may be recognized by the occurrence of sharp pain upon extension of the thumb, accompanied by a distinct crepitus. The latter is best felt when the fingers are placed along the course of the tendon, as far as the middle third of the forearm, while the thumb is alternately extended and flexed. After a few days the pain and crepitus disappear, and the patient may have an oblong swelling extending from the back of the thumb, obliquely across the back of the lower third of the forearm. This swelling shows distinct evidences of fluctuation and is the result of accumulation of fluid within the sheath.

(*b*) An *acute primary serofibrinous tenosynovitis* occurs in the flexor sheaths of the fingers, and can be recognized from the location of the pain and the fullness over the normal depressions at the folds of the fingers. The latter are held rigid, and only the terminal phalanx can be flexed. This form is a not infrequent sequel of fractures or other conditions in which the fingers are kept immobilized for too long a period.

(*c*) *Acute Primary Seropurulent Tenosynovitis.*—This also affects the flexor sheaths of the fingers. It shows the same local signs as the preceding form, but there is higher fever and more pain.

Acute Secondary Tenovaginitis or Tenosynovitis.—The acute secondary forms are due either to (*a*) infection from neighboring tissues extending through the sheath; (*b*) to gonorrheal metastasis, or (*c*) it may occur as a complication of syphilis during the secondary stage. Suppurative tenosynovitis, which is secondary to infection of the surrounding tissues, as in infected fingers, or occurs after penetrating wounds of the sheaths, has been previously referred to (page 610). The diagnosis of the acute gonorrheal and syphilitic varieties can be made as in the other forms by the occurrence of pain and swelling along the course of tendon-sheaths, accompanied by loss of function. In addition to these two signs there is usually more or less redness of the overlying skin, and the history or examination will reveal evidence of the primary disease.

All of the above-described forms, with the exception of acute tenovaginitis crepitans, affect the extensor and flexor sheaths of the hand and fingers, as well as those around the ankle (peronei, extensors, tibialis anticus and posticus). Involvement of the sheaths of the biceps brachii and of the flexors of the knee occurs less frequently. In the gonorrheal form, the condition usually occurs when the urethritis has existed for some time.

Chronic Tenosynovitis.—(*a*) *Chronic Serous Tenosynovitis.*—This may be a sequel of acute tenovaginitis crepitans, or it may follow excessive use of the hands or feet. In the fingers, it occurs in painters, engravers and artists. The diagnosis can be made from the fact that the swelling corresponds accurately either to the extensor (Fig. 458 and 459) or flexor tendon-sheaths. The sheath (*a*) may contain simply serum and the serous lining show but little change, or (*b*) it may contain many rice-like bodies (corpora oryzidæ) with marked papillomatous excrescences in the sheath wall.

(*b*) *Tuberculous Tenosynovitis.*—This form of chronic inflammation of the tendon-sheaths most frequently affects the flexors of the hand, less often the sheaths around the ankle. There are several clinical forms whose recognition is important. The first variety is characterized by a well-marked, oblong swelling, corresponding in outline to the tendon-sheaths, over which there is distinct fluctuation, and containing many rice bodies. These rice bodies can often be distinctly felt and pushed through constrictions in the sac. Perforation may occur accompanied by discharge of caseous material. In the second variety, the tendon-sheath is greatly thickened, and more or less solid tumors are formed corresponding in outline to the sheaths. In both of these tuberculous forms the diagnosis is not difficult, if there are evidences of tuberculo-

sis elsewhere. But if such a history is absent, suspicion should be aroused by the chronicity of the process and the clinical signs of one of these two forms.

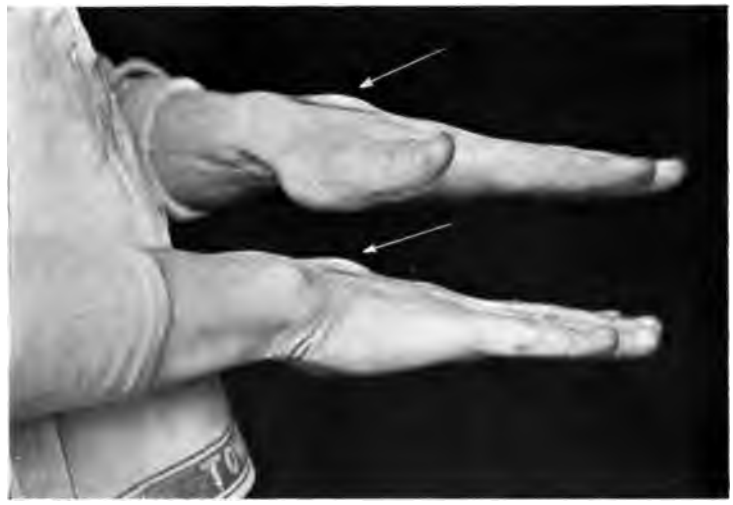


FIG. 458.—LATERAL VIEW OF CASE OF TENOSYNOVITIS OF EXTENSOR TENDON SHEATHS ON DORSUM OF HAND.

FIG. 459.—DIRECT VIEW OF SAME CASE AS SHOWN IN FIG. 458, SHOWING THE SWELLING IN THE MIDDLE OF THE DORSUM OF THE HAND DUE TO TENOSYNOVITIS OF THE EXTENSOR TENDON-SHEATHS OF THE FINGERS.

(*c*) *Chronic Syphilitic Tenosynovitis.* The acute form of syphilis of the tendon sheaths has been referred to on page 650. Both the acute and

chronic varieties are more frequently found in women, and affect the tendon-sheaths of the extensors of the fingers and toes, the biceps, and peroneus sheaths. In the chronic form a simple exudation may occur into the sheath, or a gummatous nodulated infiltration may be found. The diagnosis is very difficult unless there is a distinct history of syphilis and unless the condition clears up after the use of antisyphilitic treatment.

Tumors of Tendons and Tendon-sheaths.—Lipoma arborescens and sarcoma constitute practically the only forms of neoplasms of the tendons and their sheaths. Lipoma arborescens occurs in a symmetrical manner in the flexor sheaths of the hand, forming a soft, semi-fluctuating tumor which can scarcely be distinguished from a tuberculous inflammation. The most common forms of malignant tumors are the

FIG. 460.—SIDE VIEW OF CASE SHOWN IN FIG. 461.

FIG. 461.—FRONT VIEW OF SARCOMA ARISING FROM TENDON-SHEATH OF TIBIALIS POSTICUS TENDON.

fibrosarcomata. They are observed both in infancy and old age. Their growth is slow and usually painless. They are hard and are situated on the flexor tendons.

Ganglion.—It seems appropriate to refer here to a tumor which is usually found upon the dorsum of the wrist, but may be found upon the flexor surface of the wrist or of the fingers. The tumors vary in size from a cherry to that of a walnut. If they lie deeply, they are quite hard, but when superficial, they fluctuate. A diagnosis can be made of their consistency and location. They can be best seen when the wrist is fully extended or flexed, depending upon which side of the wrist they are located. Many communicate with the wrist-joint and are a form of hernia of the joint. According to Ledderhose and Ritschl, some are the result of a colloid degeneration of connective tissue.

DISEASES OF MUSCLES.

Inflammatory Affections

1. **Acute Muscular Rheumatism** (*Acute Serous Myositis*).—This is only mentioned in a surgical book to call attention to the fact that it may occur suddenly after muscular exertion and simulate a sprain. In addition to the severe pain, there is rigidity of the limb or joint which is moved by the affected muscle, as well as well-marked local tenderness. The affection yields rapidly to antirheumatic treatment.

2. **Acute Suppurative Myositis.**—This is almost invariably secondary to a neighboring focus of suppuration, but may occur quite rarely, as a primary form. In the latter there are manifest local disturbances, such as marked swelling and pain over the affected muscle, followed by edema and induration of the overlying skin with subsequent fluctuation.

Fig. 462.—Ganglion on the Back of the Wrist ("International Text-Book of Surgery").

3. **Simple Chronic or Fibrous Myositis** (*Sclerosing Myositis*).—This may follow (*a*) an attack of rheumatic myositis; (*b*) trichinosis; (*c*) thrombosis of the vessels of an extremity, or (*d*) the long-continued or too tight application of bandages, casts, etc.

In all of these there is overgrowth of the interstitial tissue with atrophy of muscle fibers. The muscle itself feels hard and atrophic. Contractures and loss of function usually result. After fractures, especially where the splints have been employed for a long period or the dressing was applied too tightly, this form is especially common. The condition is called *ischemic muscular contracture or paralysis.*

4. **Myositis Ossificans.**—This occurs most often in a localized form, but may occasionally be quite widely distributed in the body.

The formation of bone in the intermuscular tissue may occur as the result of either a single injury or of frequently repeated trauma. It has been given the name traumatic myositis ossificans. The most frequent location is in the adductors of the thigh, as the so-called rider's bone, or in the deltoid and pectoralis major muscles. As a more general dis-

ease, it occurs either without apparent cause or after an injury. The idiopathic form affects chiefly the muscles of the back and spine. This ossification may follow a complex of symptoms, such as high fever, swelling, and pain in the muscle. These recur from time to time, and after the attack has passed away, hard nodules are to be felt in the muscle. Every muscle in the body may be involved, with the exception of those of the face. Only forty cases of this generalized form have thus far been reported. The diagnosis is confirmed by the use of the x-ray.

FIG. 403.—FASCIAL SARCOMA OF CALF OF LEG.
The arrow points to the prominence caused by the soft, semifluctuant sarcoma.

5. **Tuberculous myositis** is usually secondary to bone or lymph-node foci in the vicinity or may occur after an injury, if there are foci elsewhere. Quite rarely multiple tuberculous abscesses are found in a muscle without any neighboring focus.

6. **Syphilitic Myositis.**—This occurs either (*a*) as an infiltrating myositis which begins as a muscular rheumatism and causes the muscle to become rigid and nodular, or (*b*) as a gumma close to the tendon or in the belly of the muscle, affecting most often the sterno-cleidomastoid and the muscles of mastication. They form hard nodules which are usually painless. They may attain the size of an apple. At times they undergo softening and discharge, their contents leaving an ulcer with serpentine outline and steep edges. The diagnosis is not

difficult if there is a distinct history of syphilis, either congenital or acquired. They need only be differentiated from echinococcus, since few other tumors occur in a muscle. The nodules disappear rapidly after the use of antisyphilitic treatment.

Tumors of Muscles.

Primary tumors are rare. These are usually *hemangiomata*, *lymphangiomata*, or *sarcomata*. *Desmoids* occurring in the muscles of the abdominal wall were previously described (page 254). Angiomata are of slow formation, extending over a period of years. In rare cases they grow within a few months. They feel like a lipoma and are not always compressible. They occur most frequently in young persons.

Sarcoma may arise in muscle as a primary tumor. It causes rapid enlargement of the part, feels quite firm, and is painless (see Fig. 463).

Hydatid Cysts in Muscles.—These occur quite often in muscles (about two per cent. of all cases). They can be differentiated from gummata by their more elastic consistency. The diagnosis of a hydatid cyst is seldom made before operation.

DISEASES OF THE FASCIÆ.

Dupuytren's Contraction.—In both young and older persons a contraction of the palmar fascia occurs, causing a flexion of one or more fingers. It usually affects the ring and little fingers, but may involve the index- and middle fingers. In the palm of the hand, one can see and feel one or more firm bands to which the skin is adherent. The skin is also thrown into transverse folds and depressions. The flexion of the fingers may be very slight, or it may be so marked that the tip of the finger almost touches the palm of the hand. The position of the hand has been likened to that in which it is held during benediction. The clinical picture is so typical that the diagnosis is easy. The only differentiation is from contraction of the fingers following opening of the tendon-sheath, as a result of injury (Fig. 307), or intentionally during the treatment of a suppurative tenosynovitis. Under these latter conditions one feels a single longitudinal band or cord, and the skin of the palm is only adherent to it. There is absence of the transverse folds and depressions, as well as of the nodules seen in a Dupuytren's contraction.

DISEASES OF THE NERVES.

Neuritis.—From a surgical standpoint great interest is attached to this condition of inflammation of a nerve-trunk. Its local causes are:

1. Pressure of a tumor or aneurysm upon the nerve, either close to its point of exit from the spinal canal or somewhere along its course.

2. The nerve may be involved by extension from a neighboring septic focus.

3. As a complication of nerve injury. Neuritis is much more apt to develop after an incomplete division of a nerve (by a knife, glass, or a bullet) than after a complete severing of its continuity.

4. As a complication of fractures or dislocations. In the former the nerve may be caught between the fragments or be pressed upon by the callus. In an unreduced dislocation the displaced head of the bone may compress the contiguous nerve-trunks.

5. Neuritis may follow temporary pressure upon or contusion of a nerve without any external signs of injury. The neuritis following too light an application of a constrictor is an example of this form.

Neuritis may present itself clinically in either an acute or a chronic form, or the latter may develop from the former. The diagnosis of the presence of a neuritis may be made from the following signs:

(*a*) Pain. This is of a boring character and continuous, not intermittent as in a neuralgia. The pain is felt along the course of the nerve and is increased by pressure upon the nerve or by movements of the limb.

(*b*) Sensory changes. At first all forms of paresthesia are complained of, viz., numbness, burning, coldness, etc. There is weakness or paresis of the muscles supplied by the affected nerve.

(*c*) Trophic changes. There is early wasting or atrophy of the muscles involved. The skin becomes glazed, the nails rough and curved, and the limb feels colder and looks bluish. Bullæ and ulcers may appear on the skin.

(*d*) Electrical changes. If the nerve has not been completely divided the reaction of degeneration is present three to four weeks after the injury. If the nerve has been totally destroyed by the injury or compression there is absence of all kinds of electrical responses.

(*e*) The muscle reflexes are lost and there are secondary contractures due to the action of the antagonistic muscles. If the nerve degeneration becomes complete there is complete anesthesia in the area of skin supplied by it and also total paralysis of the affected muscles. This condition is, however, infrequent, except after complete division of a nerve. The fact that the neighboring nerves may assume some of the cutaneous sensory distribution must not be forgotten.

A neuritis can be distinguished from a neuralgia by the facts that in the latter (*a*) the pain is intermittent and not continuous as in a neuritis. (*b*) There is an absence of pain along the nerve-trunk and

of tenderness over the paretic muscles. (*c*) In neuralgia there is no paresis or paralysis of muscles, nor loss of muscle reflexes. (*d*) There are also non-trophic or sensory disturbances and no changes in the electrical responses.

Tumors of the Nerves.—Clinically, there are five forms of nerve tumors:

(*a*) ***Traumatic neuromata*** develop from the cut ends of a divided nerve. They form an extremely sensitive palpable nodule on the end of the nerve in an amputation stump, or wherever the nerve may have been severed.

(*b*) *Neuromata dolorosa*, also called painful subcutaneous tubercles, are easily felt just beneath the skin, and cause pain and tingling in the area of cutaneous distribution of the nerve involved.

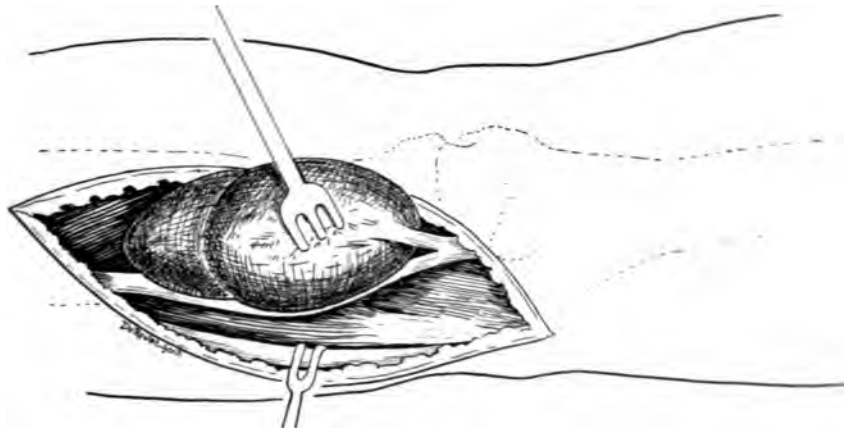


FIG. 404.—FIBRONEUROMA OF MEDIAN NERVE.

This is the case referred to on page 658, in which sarcomatous changes (see Fig. 405) occurred in a benign nerve-tumor.

(*c*) *Multiple Neuromata.*—These have also been termed plexiform neuromata and are often congenital. They seldom cause symptoms and are only to be diagnosed by the often visible, but more frequently palpable, series of nodules along the nerve-trunks. They are found clinically in three forms: (*a*) As bead-like enlargements at regular intervals along a single or several nerve-trunks; (*b*) only on a single nerve, when the symptoms of neuritis may be present and must be differentiated from those due to pressure from other causes; (*c*) invading nearly every nerve in the body.

(*d*) *Fibroneuroma.*—This form of neoplasm is composed chiefly of fibrous tissue, having its origin in the nerve-sheath. The tumors are

most frequently soft, spindle-shaped, and correspond in position to the various nerve-trunks (Fig. 464). Quite often they attain the size of a walnut and are very sensitive to the touch. Sarcomatous changes are uncommon, but should be suspected when there is a tendency to recurrence or the tumor suddenly begins to grow in all directions.

(*e*) Sarcoma of a nerve is relatively rare, and usually begins as a fibroneuroma (see above). It grows rapidly, and the diagnosis of its origin from a nerve-trunk is only made at operation in the majority of cases.

DISEASES OF THE BONES.

For diagnostic purposes affections of the bones are best divided into the acute and the chronic. The majority of both of these clinical

FIG. 465.—SARCOMA OF MEDIAN AND ULNAR NERVES.

groups are due to infective microörganisms. A small percentage of the chronic forms are the result of disturbances in metabolism.

The following will be found to be a very useful classification:

I. *Acute Diseases of Bone.*

1. Those chiefly involving the periosteum.
   - (*a*) Acute traumatic periostitis.
   - (*b*) Acute infective periostitis—this is usually secondary to acute pyogenic or infectious osteomyelitis, but the periosteum alone may be involved in some cases.
   - (*c*) Acute syphilitic periostitis. Painful nodes frequently occur in the early portion of the secondary stage (see page 672).
   - (*d*) Chronic syphilitic or tuberculous periostitis—usually secondary to the same disease of medulla, but it may be confined to the periosteum in the late secondary or early tertiary stages of syphilis (see page 673).

2. Those primarily involving the medulla.
   (*a*) Acute pyogenic or infectious osteomyelitis.
   (*b*) As a complication of compound fractures, of amputations, or of operations on bones.
   (*c*) As a primary disease, *i. e.*, the ordinary type of acute infectious or pyogenic or suppurative osteomyelitis. Most frequently due to the staphylococcus pyogenes aureus and albus, and, rarely to the streptococcus pyogenes, pneumococcus, and typhoid bacillus.

II. *Chronic diseases of bone, i. e.*, those which are primarily chronic.
1. Those due to infective agents.
   (*a*) Due to the tubercle bacillus; most frequent seat is in epiphysis or in shaft close to epiphyseal cartilage in long pipe bones. Frequent in shaft of metacarpals, metatarsals, phalanges, tarsal and carpal bones; quite rare in shafts of long pipe bones (see Fig. 466).
   (*b*) Syphilitic periostitis and osteomyelitis.
2. Bone diseases due to retrograde disturbances of nutrition.
   (*a*) Osteomalacia.
   (*b*) Rachitis.
   (*c*) Barlow's disease.
   (*d*) Acromegaly.
   (*e*) Osteoarthropathie pneumatique of Marie.
   (*f*) Osteitis deformans of Paget.
   (*g*) Phosphorus necrosis.

The majority of acute and chronic diseases of the bones occur during infancy and youth. This is especially true of acute infectious osteomyelitis and of tuberculosis of bone. Lexer[1] has demonstrated this to be due to the fact that emboli composed of clumps of bacteria, originating from a primary focus in some other part of the body, are carried to the bone through the circulation. The long and short pipe[2] bones of the extremities according to Lexer, receive their arterial supply from three sources (see Fig. 466), viz.: (*a*) A *diaphyseal* group of vessels, which extend through the shaft in both directions almost to the epiphyseal line and end here as terminal arteries. These gradually become smaller with advancing age. (*b*) A *metaphyseal* group, which enter the shaft near the epiphyseal line and branch in the direction of the epiphysis, frequently perforating the epiphyseal cartilage, and ending as terminal

[1] Lexer: "Archiv für klinische Chirurgie," vols. lxxi and lxxiii.

[2] The long pipe bones are the humerus, ulna, radius, femur, tibia, fibula, and clavicle. The short pipe bones are the metacarpal and metatarsal bones and the phalanges of the fingers and toes.

arteries in the epiphysis. These are the most important in relation to the localization of pyogenic or tuberculous infections in bone, since the majority of these are located close to the epiphyseal cartilage either on the diaphyseal or epiphyseal side. (*c*) The third or *epiphyseal* group of vessels enter the epiphysis from all sides and run toward the bone nucleus. Some, however, extend to the joint, while others pass in the direction of the epiphyseal cartilage.

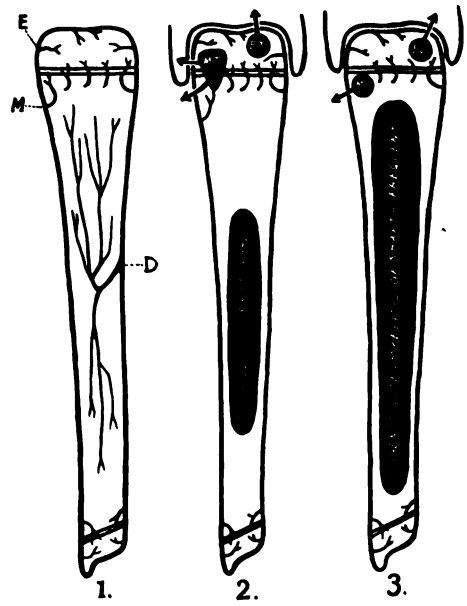


FIG. 466.—LOCALIZATION OF BONE DISEASE (modified from Lexer).

1, Normal bone. The three sets of arteries which every long pipe bone possseses are shown as E, epiphyseal; M, metaphyseal; and D, diaphyseal. 2, Localization of tuberculosis. Involvement of the shaft is quite rare (see text). MT, Focus near epiphyseal line as a result of plugging of metaphyseal vessel; ET, epiphyseal focus. 3, Localization of pyogenic osteomyelitis. Involvement of shaft in majority of cases. MO, Metaphyseal focus; EO, epiphyseal focus. The black arrows show the direction in which the pus may spread from the metaphyseal and epiphyseal foci into the adjacent joints or toward the skin.

In the diagnosis of the nature of any bone affection a knowledge of the above anatomic facts will be of great value. In the long bones of the extremities, *the focus of infection is almost invariably in or near the epiphyses*, because the terminals of all three groups of arteries are located here. In the short pipe bones, like the metacarpals, metatarsals, and phalanges, the diaphyseal vessels are large and the metaphyseal and epiphyseal vessels very narrow. Hence, *affections of these bones most frequently involve the shaft*, as is seen in the case of a spina ventosa or tuberculous dactylitis (Fig. 473).

Fränkel[1] has shown that organisms lodge in the medulla of the bones in all of the infectious diseases. They may cause no symptoms or remain latent for many years, and then suddenly be awakened into activity through some slight trauma. In general the following may be said of the two most frequent inflammatory diseases of bone:

1. Acute pyogenic or infectious osteomyelitis most frequently affects the shaft of the long bones of the extremities. Less often does it start in the epiphysis as an epiphysitis (see page 663 and Fig. 467), and it rarely invades the neighboring joints at the beginning of the disease.

[1] "Mittheilungen aus den Grenzgebieten der inneren Medizin und Chirurgie," vol. xii.

2. Tuberculosis of the bones of the extremities is most frequently found close to the epiphyseal cartilage in the shaft of the bone or in the epiphysis itself. In bones like the upper end of the femur (hip joint), where the epiphyseal cartilage lies within the joint capsule, the infection involves the joint primarily. In the other bones, the joints are far more often involved than in acute infectious osteomyelitis. In young persons a primary tuberculosis of bone with a complicating secondary tuberculous arthritis is almost the rule, while in adults it is the exception, the joint localization being primary.

I. Acute Diseases of Bone.

1. Those Involving the Periosteum Chiefly.

Acute Traumatic Periostitis.

This follows a blow or a fall upon the bone. It occurs most frequently in bones like the tibia and the lower end of the fibula, olecranon process which lie close to the surface. If the bone lies superficially, as is the case in the three locations just named, a swelling can be distinctly felt upon passing the finger lightly over the bone. The swelling feels quite firm and is very sensitive to the touch. The patient usually complains of severe pain at this point.

The course of such a contusion of the periosteum varies. It may (*a*) undergo resolution, so that the indurated area gradually disappears; (*b*) it may become softer and show distinct fluctuation, and this mass becomes slowly absorbed, or (*c*) suppuration may occur even without any external wound being present. If this latter change occurs, the indurated area becomes softer, fluctuates, and is accompanied by inflammatory symptoms. The periosteal area becomes extremely tender and painful, the skin over it is red and swollen, and, if the abscess is not opened, pus and serum will be evacuated spontaneously. In some cases, superficial necrosis of the underlying bone occurs, small sequestra being separated in five to six weeks.

Acute Infectious Periostitis.

This is rarely a primary process, and if so is quite limited in extent. It occurs as a primary affection as the result of infection from neighboring tissues, *e. g.*, in the jaws by extension from a carious tooth, in the phalanges as a complication of infection of the fingers or toes. On the fingers such a suppurative periostitis, resulting in necrosis of the underlying bone, is called a "felon" (see page 610). The periosteum

is not infrequently involved through extension of phlegmonous processes in the subcutaneous tissues of the extremities.

The diagnosis of such a suppurative periostitis cannot often be made until a sinus has formed, leading to necrotic bone. In the early stages, there is severe pain and tenderness on pressure, well localized over the point of involvement. In superficial bones, like the jaw or tibia there is a swelling present on the periosteum which may fluctuate, and after discharging pus, one can feel the exposed bone with a probe, and after one to two months sequestra separate and can be extracted.

2. THOSE INVOLVING THE MEDULLA PRIMARILY.

Acute Infectious or Pyogenic Osteomyelitis.

This occurs most often in young persons and may appear in a single bone or in several simultaneously. It is a disease which almost invariably begins in the shaft, and may involve the adjacent joints secondarily. It rarely occurs after complete ossification of the epiphyseal cartilage. When it occurs in adults, it is usually the result of the awakening into activity of a previously existing osteomyelitic focus. The tibia and femur are more often the seat of the disease than any other bones of the extremities. In Trendel's statistics, based on 440 cases from v. Bruns' clinic, the percentages were as follows: femur, 38.5; tibia, 38.5; humerus, 11.1; radius, 5.1; fibula, 3.4; ulna, 3.4. Next in order of involvement are the humerus, radius, fibula, ulna, and pelvis. The number of cases in the different years of early life gradually rises to the tenth year, and is highest at the seventeenth year. The greatest number of cases occur between ten and seventeen years. After seventeen years the number rapidly decreases, and after twenty years the number of cases is few (Trendel[1]).

The organism most frequently concerned is the staphylococcus pyogenes aureus. There are undoubtedly cases of acute osteomyelitis which are due to other organisms.

To this latter class belong those which are caused by (*a*) the streptococcus pyogenes; (*b*) the typhoid bacillus, and (*c*) the pneumococcus. It is almost impossible clinically to distinguish an osteomyelitis due to these three organisms, from that caused by the staphylococcus pyogenes aureus. Lexer and Klemm have shown that there is but little difference, from either a clinical or pathologic standpoint. One may, however, find an infection atrium, such as an infected streptococcus wound, a pneumonia, an otitis media, a pharyngitis of some kind, an infected

[1] "Beiträge zur klinischen Chirurgie," vol. xli.

umbilicus, etc. There is also apt to be more edema of the soft parts, especially in the streptococcus variety. A widespread phlegmon of the shaft is rare in both of these forms, as well as in that due to the typhoid bacillus. The focus is usually quite localized and often subperiosteal. In infections by the typhoid bacillus no acute purulent focus is produced unless there is a mixed infection with the ordinary pyogenic cocci. Typhoidal periostitis is often the chief result of infection with this organism, especially in the ribs.

The diagnosis of the ordinary form of acute pyogenic or infectious osteomyelitis is, as a rule, not difficult. There are, however, three distinct clinical types:

1. It may begin suddenly with swelling over the affected bone, delirium, high fever, leukocytosis, rapid pulse, and other signs of a severe septic intoxication, death occurring in a few days.

2. It may appear as the so-called *acute arthritis of infants* from three weeks to two years of age. The onset is sudden, there is marked rise of temperature, rapid pulse, and other signs of septic intoxication. The joint is swollen and very painful. The local swelling may be followed by pus formation, which is often evacuated spontaneously. In the severer cases separation of the epiphysis occurs with disorganization of the joint. It has been clearly shown that these cases of *acute septic arthritis* of infants and young children are the result of a rupture into the joint of an osteomyelitic focus situated on the shaft side of the epiphyseal cartilage of the upper end of the femur. The suppurative arthritis, which is the most prominent clinical symptom, is due (*a*) to the fact that (as in the hip) the epiphyseal cartilage lies within the joint, or (*b*) that the focus ruptures into the joint cavity, or (*c*) it burrows through the epiphysis and then invades the joint. To this form of the disease the name *epiphysitis* has been given in England (Fig. 467). It can also occur in older children and lead to complete separation of the epiphysis—a condition termed epiphyseolysis; or it may cause partial destruction of the epiphysis, producing during the growth of the bone a static deformity. In the case from which the skiagraph shown in Fig. 467 was taken, there was a genu valgum due to destruction of the epiphyseal cartilage on the inner side of the tibia. The destruction of the entire epiphyseal cartilage is quite rare, and causes a retardation in the growth of the bone.

3. The ordinary clinical form of acute pyogenic or infectious osteomyelitis may arise as (*a*) a complication of compound fractures, of amputations, or operations on bones, or (*b*) it may follow a slight trauma or exposure to cold or wet, or develop in the course of an infectious

disease like pneumonia, typhoid, scarlatina, variola, etc. The author recently saw a case of acute osteomyelitis of the upper epiphysis of the humerus with secondary suppurative arthritis of the shoulder-joint following an infection of the umbilical cord during the first weeks of life. This is not at all uncommon. The clinical history is as follows: The disease begins suddenly with severe pain and tenderness over the affected bone, usually of the shaft, or over several bones, if multiple foci exist. A chill often ushers in the disease, followed by high fever. The temperature curve resembles greatly that of a typhoid, being of a continuous type. The limb soon becomes swollen, tender, and indurated. The skin glistens, is red, and feels hot. There is rigidity of the adjacent joints. If no surgical relief is given one of two conditions results: (*a*) A septicemia develops with high fever of a continuous type, rapid pulse, dry-coated tongue, marked leukocytosis, delirium or stupor, sweats, and diarrhea.

FIG. 467.—SKIAGRAPH OF CASE OF ACUTE EPIPHYSITIS (OSTEOMYELITIS OF EPIPHYSIS).

The separation (epiphyselysis) of the epiphysis in its inner half from the diaphysis is well shown.

(*b*) In less severe cases the pus perforates the cortical portion of the shaft and the periosteum, and appears beneath the skin as an abscess with distinct fluctuation. The patient may present himself with a sinus leading to necrotic bone in the shaft and give a history of such an acute onset as just described. In some of the subacute and chronic cases spontaneous fracture (page 505) may occur.

If the medulla has not been sufficiently drained, the septic symptoms may persist. The fever shows a distinct rise in the evening (hectic type) with morning remissions. The limb remains brawny and swollen, and considerable pus continues to be discharged from the wound of operation or sinus.

A chronic condition may result from an acute osteomyelitis and last for many years. The sinus leading to the original focus may heal and then after years an acute exacerbation may supervene. The diagnosis in such cases can be made from the previous history, the presence of a scar over the shaft, and the local inflammatory signs.

In some cases, an encapsulated abscess may exist for many years. It has been called a chronic bone abscess. The diagnosis in these cases can be made (*a*) from the frequently recurring pains; (*b*) the evening rise of temperature, and (*c*) from the presence of tenderness on pressure over the bone focus.

The Use of the *x*-Ray in Acute and Chronic Affections of the Bones.—A skiagraph has become a most valuable, and in some cases an indispensable, adjunct in the diagnosis of the various acute and chronic bone diseases.[1]

The x-Ray in Osteomyelitis.—The recognition of osteomyelitis through *x*-ray examination is dependent upon the period of development of the disease, during which the skiagraph is made. Before periosteal new bone formation has begun or the medulla has been entirely broken down as the result of the suppuration, it is impossible to get any positive results. The first visible changes occur during the second week of the disease. An earlier examination should, however, never be omitted, since the acute process may simply be an exacerbation of one of longer standing, which latter has caused visible bone changes.

FIG. 468.—ACUTE OSTEOMYELITIS OF THE TIBIA (Nichols).

The *x*-ray will, however, enable one to differentiate a chronic osteomyelitis from other bone conditions, such as tuberculosis, syphilis, sarcoma and bone cyst. During the formation of sequestra the *x*-ray picture is especially typical. The irregular, very thick, but lighter shadow of the involucrum (formed by the periosteum) is seen surrounding the sequestrum, which gives a deeper shadow.

In cases where a sequestrum is present and lies in the center of the bone, the *x*-ray will show a very dense shadow (due to the sequestrum), surrounded by a lighter area due to the abscess cavity in which the sequestrum lies, and this lighter shadow surrounded by a darker, but

[1] The *x*-ray appearance of the various bone affections will be considered under the individual diseases.

wider and more diffuse shadow, due to the process of osteosclerosis which has taken place in the remainder of the bone.

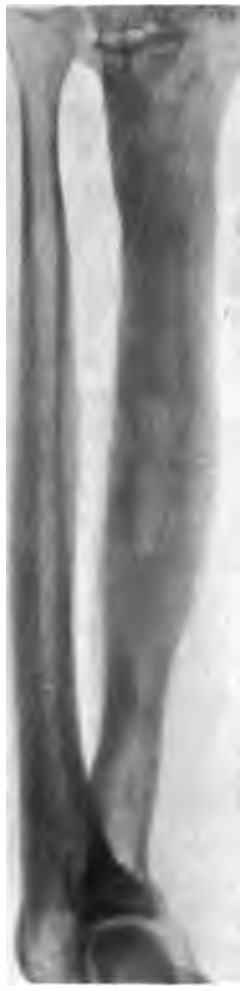


FIG. 469.—SKIAGRAPH OF OSTEOMYELITIS OF TIBIA SHOWING OSTEOSCLEROSIS (Rumpel).

Note the absence of any differentiation between the dark normal shadow of the cortex and the lighter shadow of the medulla.

In acute osteomyelitis, *i. e.*, after the second week, the *x*-ray findings are also quite typical. The shadow of the medulla is lighter in places than normal, as the result of the absorption of the bone trabeculæ. The beginning stages of periosteal new bone formation can be seen in the great widening of the periosteal shadow. Osteosclerosis as the result of chronic osteomyelitis can be recognized (*a*) by the irregular outline of the bone due to the great amount of periosteal new bone formation (ossifying periostitis, and (*b*) by the absence of any line of demarcation between the cortex and medulla. This latter diffuse shadow is the result of the uniform ossification of the medulla.

In general, it may be said that an ossifying periostitis which surrounds the greater portion of or the entire shaft, is characteristic of osteomyelitis. In a sarcoma, the new formation of bone as the result of an ossifying periostitis is more localized at the ends of the diaphysis.

Differential Diagnosis of Acute Osteomyelitis.—*Typhoid Fever.*—The first clinical form of acute osteomyelitis described above (see page 664) may resemble typhoid fever. The temperature is high and of a continuous type, and there is stupor and delirium in both. In acute osteomyelitis, however, there is a high degree of leukocytosis and absence of the Widal test, unless the patient has had a recent typhoid. In addition the local evidences of inflammation, such as severe pain and tenderness over the affected bone, redness, swelling, heat, etc., appear early.

Acute Articular Rheumatism.—No disease is more frequently mistaken for acute infectious osteomyelitis than this. It is recognized by the successive involvement of many joints, which is usually transitory. The

tenderness, pain, and swelling are over the joints, and not over the bones, as is the case in acute infectious osteomyelitis. The acute arthritis (see below) of infants and young children, which occurs as the result of localization of the infectious osteomyelitis in the epiphyses, with early involvement of the joints, is, as a rule, confined to one joint, most often the hip and shoulder. Profuse sweats, multiple joint involvement, and early response to salicylates are also characteristic of rheumatism.

FIG. 470.—X-RAY OF CASE OF GUMMATOUS OSTEOMYELITIS AND PERIOSTITIS OF CLAVICLE
Note the greatly thickened periosteum and the loss of the normal lighter shadow of the medulla due to osteosclerosis.

Infectious Arthritis.—The second type of acute osteomyelitis, in which the focus lies in or near the epiphysis, may greatly resemble arthritis due to other causes. This is especially true of osteomyelitic foci at the upper and lower ends of the femur, and the upper end of the humerus. The symptoms are generally more severe both in infants and older children than in an arthritis due to other causes. The pain, swelling about the joint, and fever are very marked. Abscess formation follows in the majority of the cases, and is preceded by a high degree of leukocytosis.

Epiphyseal separation is quite common in the cases of

osteomyelitis close to a joint, and the diagnosis can often be made from the resultant deformity and the use of the *x*-ray (Fig. 467 and page 663).

In subacute cases of epiphyseal infectious osteomyelitis it is impossible before operation to make a differentiation from tuberculosis of the joints.

Tuberculosis of Bone.—In the more acute types of infectious osteomyelitis there should be no difficulty in making a differentiation from tuberculosis. The pain, leukocytosis, local swelling and tenderness, high fever, etc., are all characteristic of an acute osteomyelitis.

FIG. 471.—EXTERNAL APPEARANCE OF LEFT THIGH IN A CASE OF OSTEOMYELITIS OF THE FEMUR.

The arrow points to the swelling caused by the involucrum and thickening of the subcutaneous tissue.

There are certain subacute cases of osteomyelitis which may resemble a tuberculosis. There are, however, even in these cases certain points of difference. *Tuberculosis affects the shaft close to the epiphysis, or the epiphysis itself, while it is rare in the shaft of the long bones. Acute infectious osteomyelitis is most frequently a disease of the medulla of the shaft and is rarely situated close to the epiphyses.* The history of pain, rise of temperature, and the local signs, such as tenderness on pressure, swelling, etc., are all more marked in an acute infectious osteomyelitis. An *x*-ray will show greater thickening of the bone, due to involucrum formation in osteomyelitis (see page 666). If a sinus exists, the granulation-tissue will often be of great aid in making a diagnosis, being caseous and flabby in tuberculosis, and if examined microscopically, will show giant-cells and tubercles.

II. Primarily Chronic Diseases of Bone.

1. Those due to infective agents.

Tuberculosis of Bone.—This may occur clinically in the following forms:

1. As single or multiple foci in the epiphyses of the long pipe bones, *e. g.*, femur, tibia, humerus, ulna, radius, fibula, and clavicle.

2. As a tuberculous osteomyelitis of the short pipe bones, *e. g.*, metatarsals, metacarpals, and phalanges of the toes and fingers.

3. In the spongy bones of the carpus and tarsus.

4. In the flat bones, *e. g.*, pelvis, scapula, ribs, sternum, and skull.

A tuberculous osteomyelitis of the shaft or a diaphysis of the long pipe bones is very rare. Nichols states that he has been unable to find it in one hundred and twenty cases studied by him, and Küttner was only able to discover six cases in a total of two thousand, one hundred and twenty-seven cases of tuberculosis of the bones and joints in von Bruns' clinic (0.28 per cent.).

Fig. 472.—External Appearance of Thigh in a Case of Osteosarcoma of the Lower End of the Femur Simulating Tuberculous Osteomyelitis.

The *diagnosis of tuberculosis of bone* varies according to its localization.

1. If situated in the epiphyseal ends of the long pipe bones, the symptoms of the secondary joint affection may predominate to such an extent that a primary bone focus is only to be suspected from the generally accepted fact, that *in the majority of cases tuberculous arthritis is secondary to a primary bone focus.*

In bones like the olecranon, upper and lower ends of the tibia, clavicle, lower end of the femur or radius, which are accessible to inspection and palpation, the presence of a tuberculous focus may be suspected from the following symptoms:

1. A localized tenderness and swelling, accompanied by moderate pain upon pressure or movements of the limb. The pain is never severe, as in an infectious osteomyelitis, and there is but little if any fever. If caseation and perforation of the periosteum have occurred, the presence of fluctuation and the history of slight pain preceding the appearance of the swelling render the diagnosis of tuberculosis probable.

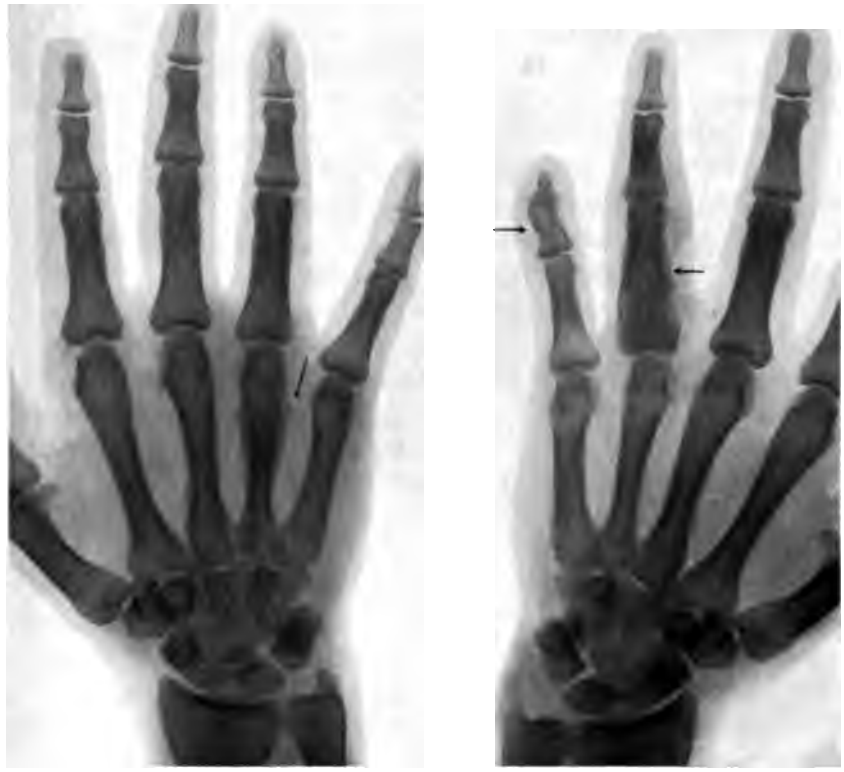


FIG. 473.—X RAY OF A CASE OF TUBERCULOUS DACTYLITIS, OF LEFT METACARPAL BONE OF RING-FINGER, OF SECOND PHALANX OF RIGHT MIDDLE FINGER, AND FIRST PHALANX OF RIGHT RING-FINGER.

2. Tuberculous osteomyelitis occurs chiefly in the short pipe bones of the hands and foot, *e. g.*, metacarpals, metatarsals, and phalanges. It has been termed tuberculous dactylitis or spina ventosa. To some extent, the ulna resembles these short pipe bones, in the fact that tuberculous localization, if it does not occur in the olecranon process, is most apt to take place in the shaft. The short pipe bones—*i. e.*, metacarpals and phalanges of the fingers—of the hand are far more frequently involved than those of the foot, viz., metatarsals and phalanges of toes.

The affected bone is expanded and becomes spindle shaped. This thickening of the bone is so marked as to be distinctly palpable, and can be seen in a skiagraph (see Fig. 473 and page 670). Such an enlargement of the bone seldom occurs in the epiphyseal form of tuberculosis, but if present, it takes place at the lower end of the radius and upper ends of the tibia and ulna.

In addition to the enlargement of the bone, perforation of the overlying periosteum occurs at an early period with the formation of a sinus discharging thin yellow pus and lined by pale, flabby, often caseous, granulations. Such abscesses and sinus formations occur at an early stage in the case of tuberculosis of the metacarpals and metatarsals, but at a late stage in the case of the phalanges, which latter may remain enlarged for a long time before sinus formation occurs. *Syphilis* causes a similar enlargement of the short pipe bones, but can be differentiated by the fact that it occurs chiefly in infancy, and there is no abscess formation. The history and a search for other evidences of syphilis will usually clear up any doubts. Should the latter, however, exist, the administration of anti-syphilitic remedies should be instituted.

3. Tuberculosis of the tarsal bones is more frequent than that of the carpal bones. In lesions of both of the [illegible] symptoms predominate and will be referred to [illegible] culous joint disease.

4. Tuberculosis of the flat bones of the [illegible] pelvis, may occur either along the crest of the ilium, the [illegible] pubis, or in the acetabulum. The latter [illegible] ing-point of a hip joint disease.

In the crest of the ilium and [illegible] rare, and difficult to recognize until [illegible] down to carious bone or [illegible].

Tuberculous periostitis [illegible] ribs and has been [illegible].

x Ray Appearances.—[illegible] evidence [illegible] compact [illegible] crease [illegible] bone [illegible] form [illegible] [illegible] [illegible] [illegible]

(tuberculosis of short pipe bones) the shaft is expanded, but there is a loss of bone structure either centrally or at the periphery (Fig. 473). In a syphilitic dactylitis the greatly thickened periosteum either surrounds the intact shaft or the latter gives a deep shadow (Fig. 470) as the result of new-formed bone.

FIG. 474.—METHOD OF PALPATING THE PERIOSTEUM OF THE TIBIA.

The fingers are laid flat upon the limb, the tips resting upon the internal surface of the tibia or shin, and the hand then passed along the entire length of the tibia.

Syphilis of Bone.—Syphilis affects the bones both in the hereditary and acquired forms of the disease. The localization and pathologic changes are similar in both and will be described together. In hereditary syphilis there is, however, a greater tendency to secondary joint involvement, the clinical signs of which will be referred to in the section on joint diseases (see page 712).

The following are the most frequent localizations of syphilis:

1. As a periostitis:
   (*a*) In the early portion of the secondary stage.
   (*b*) In the late secondary stage.
   (*c*) In the tertiary stage.
   (*d*) In late hereditary syphilis (syphilis hereditaria tarda).
2. As a gummatous osteomyelitis:
   (*a*) In the tertiary stage.
   (*b*) In the hereditary form.

In hereditary syphilis, bone changes appear (*a*) as an osteomyelitis of the epiphyses of the long pipe bones, causing pain, marked enlargement of the end of the bone, a swollen joint, and loss of function of the limb (*syphilitic pseudo-paralysis*).

FIG. 475.—PERIOSTITIS SYPHILITICA IN A BOY OF SIXTEEN, SUFFERING FROM SYPHILIS HEREDITARIA TARDA.

This is the same case as shown in the *x*-ray of Fig. 477. The arrow points to the prominence along the entire internal aspect of the tibia.

(*b*) As an osteomyelitis of the short pipe bones (syphilitic dactylitis), which can be differentiated from a tuberculous condition by the absence of a tuberculous history and of a tendency to abscess formation and the rapid improvement under antisyphilitic treatment.

(*c*) As an osteomyelitis anywhere in the body with resultant necrosis and sinus formation.

(*d*) As an osteoperiostitis in that form of hereditary syphilis which appears about the age of puberty, called "syphilis hereditaria tarda." The diagnosis of the latter two forms does not differ from similar conditions observed in the late secondary or in the tertiary stages of acquired syphilis (see below).

Acquired Syphilis.—In the early weeks of the secondary stage

one of the most marked symptoms, which appears just before the cutaneous eruption occurs, is the acute periostitis of the cranial bones (see

FIG. 476.—X-RAY OF CASE OF SYPHILITIC PERIOSTITIS OF TIBIA, EXTERIOR PICTURE OF WHICH IS SHOWN IN FIG. 475.

page 76). In the late secondary or early tertiary periods this localization is so characteristic that the diagnosis is usually not difficult.

The disease most often involves the tibia, but may first show itself in the clavicle. The signs are (*a*) severe pain over the affected bone which is most marked at night, except in those who sleep during the day on account of their occupation, in which case they are most severe during the latter period. (*b*) Palpation of the bone reveals a distinct thickening of the periosteum and exquisite sensitiveness to the touch. This inflammatory form of syphilitic bone localization may be quite circumscribed (periosteal nodes) or diffuse. Even after the disease has subsided the affected bone may show upon palpation, alternating elevations and depressions, which may be of some aid in making a diagnosis of syphilis at some future period. These elevations are the result of ossification of the periosteal nodes.

Gummatous Periostitis and Osteomyelitis.—These occur in the tertiary stage in one of two forms: (*a*) As a superficial periosteal gumma; (*b*) as a circumscribed or diffuse gummatous infiltration of the medulla of the shaft.

The periosteal gumma, which varies from the size of a walnut to that of an apple, appears as a painful, superficial tumor, which may become soft and show evidences of fluctuation, or gradually disappear under treatment. At times they may break down and perforate the skin, or ulceration takes place with the formation of typical reniform, steep-edged ulcers.

A gummatous osteomyelitis causes a dull aching pain in the bone without palpable changes in the periosteum. There may be an accompanying marked enlargement of the shaft of the bone or extensive necrosis may occur. In some cases, a spontaneous fracture may be the first sign of the presence of the disease.

The diagnosis of the various forms of bone syphilis is usually not difficult, if there is a distinct history or there are evidences of the disease elsewhere. In no other bone affection are the thickening, pain, and tenderness of the periosteum so marked. The nocturnal exacerbation of pain is also characteristic.

Tuberculous periostitis, as was stated, is very rare as a primary affection, and if present usually shows early signs of suppuration.

If the periosteum has increased in thickness rapidly, and the enlargement is quite marked and not very painful, the question of the possibility of a periosteal sarcoma arises. This is especially true if there is but little response to antisyphilitic treatment, and the history of a previous syphilis is not clear. In such cases an exploratory incision is often necessary.

The gummatous form of osteomyelitis, if it be accompanied by

considerable osteosclerosis and enlargement of the bone, must at times be differentiated from an osteosarcoma, especially if situated at the epiphyseal ends of the long bones. A gumma in such a situation causes a unilateral, while a sarcoma causes a uniform, enlargement.

A gumma of the short pipe bones of the hand and foot (metacarpals, metatarsals, and phalanges) can be differentiated from a tuberculous osteomyelitis (spina ventosa) only by the greater tendency of the latter to suppurate and the fact that antisyphilitic treatment causes no improvement.

FIG. 477.—SYPHILIS OF METACARPAL BONE.

Note the great thickening of the periosteum involving the shaft, and the absence of any demarcation between the cortex and medulla, as is characteristic of a gummata osteomyelitis.

X-ray Appearance of Syphilis of Bone.—The thickening of the periosteum (Fig. 475) is one of the most characteristic evidences of syphilis in the *x*-ray picture. This means a gummatous deposit in the periosteum. In some instances (Ware[1]) this gummatous material encroaches upon the cortex, materially contributing to the thickening of the bone. If a gummatous osteomyelitis is present, there is a considerable increase in the diameter and the distinctions in the shadows perceptible in a normal bone become obliterated. The cortex appears as a denser shadow, often encroaching upon the medulla so as to obliterate it. If, as in the periostitis, this gummatous material breaks down, there are areas of more or less translucency, surrounded by denser shadows, due to areas of greater bone activity (osteosclerosis). The gummatous deposit in the periosteum is attended at times by a growth in the length of the bones, resulting in a bowing of the bones. This condition is especially frequent, according to Fournier, in young adults suffering from late hereditary syphilis, and is well shown in Fig. 475. The *x*-ray is of great aid in distinguishing syphilitic and tuberculous dactylitis (compare Figs. 473 and

[1] Ware, "Surgery, Gynecology, and Obstetrics," vol. vi, p. 9.

477). In syphilis, the greater share of the dense shadow is the result of periosteal thickening surrounding the expanded shaft, while in tuberculosis there is little periosteal involvement and the bone appears eaten away and full of translucent areas.

OSTEOMALACIA.

This is a disease of bone in which absorption of lime salts occurs in healthy bone.

Bending of the softened bone leads to marked deformity, and the occurrence of spontaneous fracture is common. The majority of cases reported have been in women (91 per cent.), and of these it occurred during pregnancy in 70 per cent.

There is, however, a non-puerperal form, which is of constantly increasing interest to surgeons, since the spontaneous fractures occurring as the result of it may be easily diagnosed as being due to bone neoplasms. The most characteristic symptoms of the puerperal and non-puerperal forms are:

1. Rheumatoid pains in the spine and the extremities without swelling, but accompanied by marked muscular weakness.

2. In the non-puerperal form there is a history of malnutrition and of unhygienic surroundings.

3. Deformities. These may be (*a*) of the spine—there is a gradually increasing curvature of the spine, which may be in a backward, forward, or lateral direction; (*b*) of the pelvis—the walk becomes waddling, like that of double congenital hip dislocation, the pelvic bones becoming misshapen; (*c*) of the chest—this assumes a barrel shape or the ribs sink in; (*d*) of the extremities—there is marked bending of the long bones.

4. Spontaneous fractures. These occur at an early period. They may be single or multiple, and *the possibility of an osteomalacia must always be borne in mind in cases of apparently spontaneous fracture.*

5. Owing to the absorption of the calcium salts, the *x*-ray will show a lighter shadow than normal bone does.

Differential Diagnosis.—The bone diseases from which osteomalacia must be differentiated are:

(*a*) *Osteosarcoma*, especially of the soft medullary type. This may, like osteomalacia, cause a spontaneous fracture as its first symptom. Usually, however, there is a history of deep-seated pain located in the shaft of one of the long bones, not diffuse, like that of osteomalacia, *i. e.*, felt in various parts of the body.

(*b*) *Osteitis Deformans.*—This occurs chiefly in elderly people, but may begin before forty. The accompanying rheumatic pains and the increasing curvature of the spine and lower extremities resemble those of osteomalacia, but there gradually develops an irregular nodular thickening of the various bones. In addition the *x*-ray will show that the normal deep bone shadow is not absent as in osteomalacia.

(*c*) *Rickets.*—This causes bending of the bones, but never marked as in osteomalacia, spontaneous fracture is infrequent, and rachitis occurs at a much earlier age than osteomalacia.

RACHITIS (RICKETS).

The diagnosis of this form of bone disease usually presents no difficulties. The most characteristic symptoms are:

1. **Deformities.**—These are most marked in the head, spine, thorax, and extremities.

(*a*) *Head.*—The head is larger than normal and of a square or box-shape, owing to the formation of bosses over the parietal and frontal eminences. The sutures and fontanelles remain open longer than normal. The occipital bone often shows abnormal softness or parchment-like crackling (craniotabes) on pressure. This rachitic condition is frequently accompanied by a variable degree of hydrocephalus.

(*b*) *Chest.*—Nodules are to be felt at the junction of the costal cartilages and ribs, which together form a series of bead-like enlargements to which the term *rachitic rosary* has been given. In addition to this beading, the chest is flattened from side to side and the sternum often very prominent (pigeon-breast).

(*c*) *Spine.*—The most characteristic deformity is a backward curvature (kyphosis), which is uniformly distributed over the entire spine.

(*d*) *Extremities.*—The deformities are more marked in the lower than in the upper extremity. The palpable epiphyses of the various bones are markedly enlarged. This is especially pronounced at the lower ends of the radius and ulna. The femur is bent forward and outward and there is frequently an accompanying coxa vara (see page 743). The other principal deformities are genu valgum and varum (see page 747). Spontaneous and greenstick fractures are not infrequently due to rickets. The **diagnosis** can usually be made from (*a*) the box-shaped skull; (*b*) beading of the ribs; (*c*) enlargement of the epiphyses at the wrist when accompanied by great restlessness; (*d*) nervous symptoms, such as convulsions, laryngismus stridulus; (*e*) marked muscular weakness; (*f*) delayed dentition and delayed closure of the fontanelles.

There is never any breaking down of bone in rickets, or formation of sinuses. A diagnosis of rickets should never be made from a single symptom, since enlargement of the epiphyses may be due to hereditary syphilis. Again, deformities of the extremities, like coxa vara or genu valgum or varum, may be due to static or other causes. A curvature of the spine may be due to tuberculosis. The differentiation from scurvy is given below.

Chondrodystrophia Foetalis (Achondroplasia–Fetal Rickets).

This bone affection is essentially a disturbance of the normal process of ossification of the primary cartilage. The children are dwarf-like when born. The head is large, the ribs are beaded, the thorax flattened, and the long bones are bowed and shortened. The bones remain distorted and their growth is greatly retarded.

Scorbutus; Scurvy (Barlow's Disease).

This, like rickets, is a disease of childhood, although it may rarely occur in early youth or even in adult life as the result of errors of diet. About four-fifths of the cases occur between the sixth and fifteenth months (Holt). Most of the children have been in good health up to the time of the attack. The principal surgical interest in the disease is its tendency to involve the bones. A surgeon is often consulted on account of the fact that the children cry out with pain when lifted. In the majority of cases this pain and tenderness are most marked in the lower extremities, especially about the knees and ankles.

This symptom alone should always lead one to suspect scurvy, since acute rheumatism is very rare in such young children. The accompanying symptoms—(*a*) swelling near or of the large joints; (*b*) spongy, swollen, often bleeding, gums; (*c*) tendency to subcutaneous hemorrhages and to melena, as well as (*d*) the history of improper diet (prolonged use of some proprietary food or sterilized or condensed milk)—will usually enable a diagnosis to be made. In anterior poliomyelitis there is no tenderness. In actue osteomyelitis there is fever, leukocytosis, as well as local redness and heat. The swelling of the limb may resemble a sarcoma, but an *x*-ray will soon exclude a neoplasm, because the normal outlines of the bone are preserved in scurvy.

Osteitis Deformans (Paget's Disease of Bone).

This is an affection which causes a softening and bending of some of the long pipe bones and of the spine, due to absorption of lime salts with secondary formation of fibrous tissue in its stead. It usually

affects the tibia in elderly persons and soon involves the neighboring joints.

The disease attacks men more frequently than women. The average age of onset in twenty-one cases, according to Osgood and Locke, of Boston, was forty-three years. The skull is greatly enlarged, and there is neuralgia from pressure. The affection is often ushered in by a long period of rheumatic pains and headaches. The patient stands with legs bowed and spine bent gradually backward, the body is carried forward and bent at the hips. The occurrence of bow-legs late in life accompanied by enlarged skull and bending backward of the spine are the chief diagnostic features.

Osteoarthropathie Pneumatique.

This is a disease of bone which was first described by Marie. It occurs in persons suffering from chronic cardiac and pulmonary diseases, and consists of an enlargement (Fig. 478) of the end phalanges of the fingers and toes, resulting from a chronic periostitis.

Acromegaly.

This gives such a characteristic clinical picture that it seldom causes any difficulty in diagnosis. There is marked enlargement of the bones of the face (especially of the lower jaw) and of the hands and feet. It is often a symptom of tumors of the pituitary body, as was the case in the patient whose brain is shown in Fig. 44.

Tumors of Bone.

The clinical history of a patient with a tumor of one of the bones of the extremities is usually as follows: (*a*) He may present himself, for the first time, on account of a fracture which followed a very slight trauma; (*b*) he may complain of pain and tenderness over the affected bone for months to years before a palpable enlargement appears; or, lastly, (*c*) a patient who has a distinct tumor presents himself for examination and opinion.

In making a diagnosis, one must consider whether the enlargement is in reality a neoplasm of the bone or whether it is the result of some inflammatory process, and if one has excluded the latter, the next problem is to determine the nature of the tumor, as to whether it be benign or malignant, etc.

If the patient is examined for the first time on account of an apparently spontaneous fracture, the various forms of pathologic fracture enumerated on page 505 must be excluded one by one.

If the spontaneous fracture is due to the rarefaction of the osseous

tissue as the result of a neoplasm there will be the previous history, and the local findings to be enumerated below, as more or less characteristic of the different forms of bone neoplasms.

It is impossible to make a diagnosis of a bone neoplasm without referring briefly to the chief varieties and then to consider their differentiation from other conditions:

- Neoplasms of bones of the extremities.
  - Benign.
    - True or simple bone cysts.
    - Osteomata and exostoses.
    - Enchondromata.
  - Malignant.
    - Primary and secondary sarcomata
    - Secondary carcinomata.

FIG. 478.—OSTEOARTHROPATHIE PNEUMATIQUE OF MARIE OF THE JOINTS OF THE FINGERS OF BOTH HANDS. (See text.)

A group of tumors called *peritheliomata* is also found in bones which belong clinically to neither group, although they resemble the sarcomata histologically. These peritheliomata show no tendency to produce metastases, but are apt to recur locally after operation.

BENIGN TUMORS.

Bone Cysts.—That cysts occur in the long and short bones of the body has been known for many years. Virchow in 1877 was the first to attempt to explain the origin of these cysts. According to his theory,

they were the result of the softening of solid tumors, such as chondromata and sarcomata of bone. This remained a generally accepted explanation until von Recklinghausen in 1891 described a bone disease which he called osteitis fibrosa deformans. He observed numerous white to brownish-red, more or less firm tumors or cysts in the bones in three cases, associated with spontaneous fractures and bending of the bones. Histologically he found the normal medulla changed to fibrous tissue with extensive destruction of bone. The name which Recklinghausen gave the disease has been retained, and later writers believe that in the majority of cases bone cysts are the result of a low grade of inflammatory change, *osteitis fibrosa*, and that in only a small proportion of the cases is a bone cyst the result of the softening of a chondroma. Bone cysts are due to a pathologic process *sui generis*, and are not merely the product of secondary softening of true tumors of various kinds. Cysts of this type have generally, though not invariably, been observed in young individuals, and usually in the long bones. It must be conceded that the differential cystic sarcomata of the bones and bone cysts may be very difficult, even when aided by the microscope. Von Haberer[1] has reported cases of multiple bone cysts which were really genuine giant-celled sarcomata. As was stated above, the majority of writers believe that true bone cysts are due to an inflammatory process. The author has been able to collect 31 cases, including the one from which the skiagraph shown in Fig. 480 was taken.

FIG. 470.—ENDOTHELIOMA OF SHOULDER, ANTERIOR VIEW (Dr. John A. Hartwell).

Clinically such patients either present themselves for diagnosis when the bone has been broken, as in the case shown in Fig. 480, following an

[1] "Archiv für klinische Chirurgie," vols. lxxvi and lxxxi.

insignificant trauma, or patients are first seen on account of a painless but steady enlargement of the bone. The condition may either appear in only one bone (solitary bone cyst) or quite a large number of the bones of the skeleton may be involved. Pain is rarely present in these cases, and in only a few is there a history of an injury, preceding the tumor. Carl Beck,[1] of New York, was the first to call attention to the *x*-ray as a means of recognizing bone cysts. He described a marked thinning of the cortex. The outlines of the thinned cortex were, however, quite sharp. This cortex formed the boundary of an oval or spindle-like expansion of the shaft which showed a translucent area in the skiagraph. This description has been changed but little in later reports, although some writers (Helbing, Koch, and Glimm) are skeptical as to the value of the *x*-ray in the diagnosis of bone cysts.

Fig. 480.—Skiagraph of Bone Cyst of Right Humerus. Taken from author's case. Boy of twelve first seen on account of spontaneous fracture, with Dr. B. W. Henderson, of Chicago. Note the uniform expansion of upper end of shaft. Also note uniformly thinned cortex without eating through as in sarcoma.

In the author's case (Fig. 480) the *x*-ray was the only method employed, and the diagnosis of bone cyst made from the skiagraph was confirmed by operation. Upon opening the cyst a gelatinous fluid escaped and the bone cavity was lined by a thin fibrinous membrane. Microscopically, the conversion of the normal medulla into fibrous tissue was quite evident.

Kümmell believes that the differentiation of a bone cyst from a bone

[1] [illegible]

sarcoma can be made from the *x*-ray alone. In the case of the bone cyst (Fig. 480), the most characteristic feature is the greatly (but at the same time uniformly) thinned cortex. Such a uniform thinning is never found in a central, *i. e.*, myelogenous, sarcoma. The smooth cortical outline of a bone cyst looks as if it had been ground out. A sarcoma does not show such a uniform expansion of the bone, the growth being somewhat excentric. A sarcoma also reveals a periosteal new bone formation which never occurs in a bone cyst.

FIG. 481.—EXTERNAL VIEW OF DISSECTED SPECIMEN OF AN OSTEOSARCOMA OF THE UPPER END OF HUMERUS.
This is from the same case as is shown in Figs. 482 and 483.

The chief conditions from which it must be differentiated are a chronic bone abscess resulting from a former osteomyelitis, syphilis, tuberculosis, and osteosarcoma. In the last named (*a*) the growth is also very slow and gradual; (*b*) the surface is uniformly hard and does not show softer areas as in a simple bone cyst. In many cases only an exploratory incision will clear up the diagnosis. A cyst is filled with a thin yellowish serous fluid, while an osteosarcoma is solid throughout.

Chronic abscesses due to an old osteomyelitis are usually situated in the upper end of the tibia. They pursue a very protracted course and the pains occur periodically, especially after exertion. There is often some evening rise of temperature. Tuberculosis of bone seldom causes expansion of a long pipe bone, but it leads to abscesses and sinuses at an early date.

Central syphilitic gummata might give rise to deep-seated bone pain. They cause no enlargement of the bone, give a negative *x*-ray picture, and improve rapidly under antisyphilitic treatment. Up to the present time only twenty-two cases of simple bone cysts have been reported.

Osteomata and Exostoses.—These terms are frequently used to represent the same variety of tumor projecting from bone. The *exostoses* are congenital multiple tumors which are most frequently situated near the epiphyses and become ossified during puberty, at which time they are likely to cause symptoms. They are situated where the long bones grow most rapidly, viz., the lower end of the femur, upper ends of tibia and humerus (see Figs. 485 and 482). They grow very slowly, and are not accompanied by pain or tenderness. In some individuals these exostoses occur in multiple form, *i. e.*, at every epiphysis.

Exostoses may develop slowly, or in some cases rapidly, after trauma. If the growth has been rapid, a differentiation from an ossifying periosteal sarcoma is difficult. It can often only be made by an *x*-ray examination and an exploratory incision. In ossifying periosteal sarcoma which is becoming an osteosarcoma, the bone shadow is seen arranged in spicules like rays, perpendicular to the shaft of the bone, while an osteoma or exostosis shows the architecture of normal bone, *i. e.*, a demarcation into a cortex and medulla. An exostosis following a trauma can also be distinguished from an ossifying periosteal sarcoma by the fact that the growth of the exostosis ceases after a time, while that of the malignant tumor is steady and progressive.

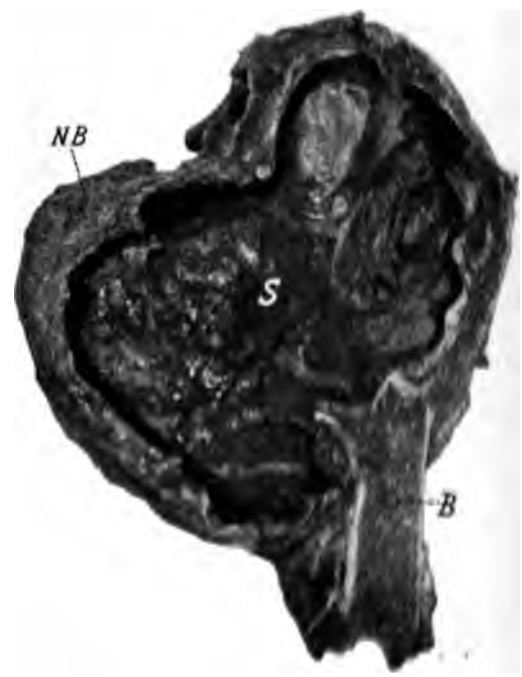


FIG. 482.—VIEW OF LONGITUDINAL SECTION OF AN OSTEOSARCOMA OF THE UPPER END OF THE HUMERUS.
NB, Ossifying periosteal layer. *S*, softer portion of tumor.

The exostoses which occur in chronic joint affections, like arthritis deformans, tabetic and syringomyelic joints, are readily diagnosed by the symptoms of the accompanying conditions.

x-Ray Appearance of Exostoses. This can be readily recognized in a skiagraph from its location close to the epiphyseal end of the long pipe

bones, especially of the femur, tibia, and humerus. In addition to this typical location, one often finds associated changes in the skeleton, such as an irregular epiphyseal line with expansion and curvature of the various bones. Exostoses usually occur in many places. The form of the bony outgrowth is as typical as its location.

It may look like a hook, or it may be rounded or irregular or cauli-

FIG. 483.—X-RAY OF THE OSTEOSARCOMA OF UPPER END OF HUMERUS, SHOWN IN FIG. 482.

flower-like. The base is always broad and shows a sharp demarcation from the surrounding soft tissues. In the structure of exostoses one recognizes the bone trabeculæ. The structure of the bone itself remains unchanged. The majority of exostoses are composed of bone alone, but there may be a combination of an exostosis with an enchondroma, or of an exostosis and a bone cyst. After the bones cease to grow, an exostosis will, as a rule, remain stationary, but in some cases

they may begin to grow in later life and assume enormous proportions. Malignant changes may occur in exostoses by which they become sarcomatous and begin to enlarge rapidly.

Enchondromata.—These occur as nodulated elastic tumors, which have the consistency of cartilage. Quite rarely, they are soft, as the result of a myxomatous degeneration. This softening has been referred to under Bone Cysts, on page 682. They may occur as pure chondromata

FIG. 484.—SKIAGRAPH OF MULTIPLE ENCHONDROMATA OF METACARPAL BONES AND PHALANGES OF THE RIGHT HAND (Rumpel).

or as mixed tumors, *e. g.*, myxochondrosarcomata or osteochondrosarcomata. The two latter will be referred to under Sarcomata of Bone.

Pure enchondromata occur most frequently in the following bones,—scapula, pelvis, long and short pipe bones of the extremities, and phalanges of the fingers and toes. In the two latter situations, they occur more frequently than in any other portion of the body. In the metacarpal bones they occur as central tumors, which gradually cause an

expansion of the bone like a spina ventosa. On the fingers and toes enchondromata occur as multiple tumors and pursue a very benign course, but in other bones they may grow to enormous size. The diagnosis of enchondromata of bone is not difficult on account of their (*a*) slow growth; (*b*) consistency; (*c*) location as single or multiple tumors at the epiphysis; (*d*) the *x*-ray shows a light shadow; (*e*) absence of pain and tenderness.

X-ray in Chondromata.—The *x*-ray shows that the majority of enchondromata of bone have their origin in the center of the shaft, especially in the portion nearest the epiphysis. One seldom sees a chondroma which has had its origin in the peripheral portion of the shaft. One sees in skiagraphs all stages. In the earliest stage one finds simply a clear,

FIG. 485.—SARCOMA OF KNEE-JOINT.
Observe the flexion contracture, and the enormous enlargement of the lower end of the femur in which the tumor was primary.

translucent, structureless area in the center of the bone. This causes more or less expansion and thinning of the cortex, quite similar to the *x*-ray appearance of a bone cyst (Fig. 480). As the tumor grows it penetrates the cortex, and the entire bone structure may be replaced by the translucent cartilage. In the early stages the sharp demarcation of the light areas from the normal medulla is quite characteristic of cartilage tumors. Some cases show a pedunculated growth covered by a very thin bone shell. The disappearance of the trabeculated structure of the medulla and its replacement by light cartilage areas, the thinning of the cortex, and the entire absence of any periosteal thickening or new bone formation are very typical. In the long pipe bones (humerus, tibia, femur) a series of light areas often appear, giving it a speckled appearance.

Malignant Tumors of Bone.

Sarcoma of Bone.—This is the most frequent form of bone tumor. As secondary growths, sarcomata of bone are a frequent result of metastasis of a primary sarcoma of the breast, testis, etc. They differ from the secondary carcinomata of bone in the clinical fact that the primary carcinoma is often insignificant when bone metastases occur, while in the case of sarcoma the bone metastases appear at an earlier period than in carcinoma and the diagnosis of the primary growth has usually been made. Many patients with malignant bone neoplasms may present themselves for diagnosis on account of a fracture, which has either occurred spontaneously or after a slight violence. Other cases may present themselves with the history of a tumor of the testis or other organs having been operated upon one to two years previously, followed by pain over the hip, limping, and shortening of the lower limb, as shown in Fig. 488. An *x*-ray in such cases shows a clear space opposite the head of the femur, due to bone absorption by the metastatic growth.

Fig. 488. Front View of Case of Central (Myelogenous) Sarcoma of Upper End of Right Humerus.

The diagnosis of secondary sarcomata differs from that of the primary forms, only through the absence of a primary focus, and the fact that the secondary forms show a more rapid growth and exhibit less of a tendency to ossification.

Primary Forms of Sarcomata of Bone.—In the diagnosis of these an effort should be made to include, if possible, the exact variety of sarcoma, since, from a clinical point of view, they differ greatly in their malignancy.

They generally occur in two forms: One, the periosteal, and the other the myelogenous. Both forms have as seats of predilection the epiphyseal ends of the long pipe bones (see Figs. 486 and 492). The following table shows the percentage:

Upper epiphysis of tibia,.....	35 per cent.
Lower end of femur,.....	18 "
Upper end of humerus,.....	13 "
Ulna and radius,.....	4 "

The periosteal sarcomata are usually of the small round and spindle-celled type. They give rise to enormous tumors, which often undergo

FIG. 487.—SARCOMA (MYELOGENOUS) OF UPPER END OF HUMERUS.
Same patient shown in Fig. 486

FIG. 488.—UPWARD DISLOCATION OF NECK AND SHAFT OF FEMUR, FOLLOWING ABSORPTION OF HEAD, THE RESULT OF A METASTATIC SARCOMA. PRIMARY GROWTH IN TESTIS (X-RAY COPY).

ossification, the lime salts being deposited in a needle-like manner radiating from the shaft (see Fig. 489). Giant-celled sarcomata of the periosteum are quite rare.

Myelogenous sarcomata may be of the round, spindle-, or giant-celled type. These tumors cause rapid expansion of the medulla (see Fig. 491). This form often occurs as an osteochondrosarcoma or as a myxochondrosarcoma.

In general, it may be said that the more cellular a bone sarcoma is, the more rapid is its growth and the greater its malignancy.

The diagnosis of bone sarcomata may be made from the following data:

1. They occur at the epiphyseal ends of the most rapidly growing bones (femur, tibia, and humerus) of young adults. Only 5 per cent. occur beyond the age of forty.

2. In the periosteal form, a palpable enlargement of the bone appears quite early, and is soft unless ossification has occurred.

3. In the medullary form, the patient complains for some time of pain over the end of one of the above-mentioned long bones. After a variable period a swelling appears at the seat of pain, and may be hard or soft, according to the amount of osseous tissue.

4. Trauma in young adults, followed by pain and tenderness which do not disappear within a month, should be watched as indicating the possibility of development of sarcoma.

5. A rise of temperature, and effusion into the adjacent joint is not uncommon, especially in the periosteal form.

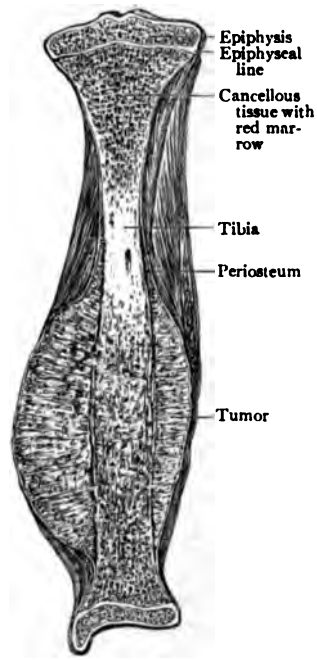


FIG. 489.—SECTIONAL VIEW OF OSSIFYING PERIOSTEAL SARCOMA OF THE TIBIA IN A GIRL (J. Bland-Sutton).

6. The growth of bone sarcomata varies greatly. In the giant-celled and in the osteosarcomata it is very slow. In the other varieties it is more rapid and progressive than that of any other form of bone neoplasm.

7. The *x*-ray is of value in distinguishing bone neoplasms from inflammatory processes or trophic changes. It may be said that the more cellular types, like the periosteal and the small rounded myelogenous sarcoma, generally show a translucency or faint shadow (Fig. 490) wherever the bone has been involved. This involvement is often excentric, *i. e.*, not so often in the center of the shaft as in bone cysts (see Fig. 480).

The ossifying periosteal and myelogenous sarcomata give the most typical pictures. In the former (periosteal osteosarcoma) the fine spicules of bone are shown radiating from the periosteum. In the central or myelogenous osteosarcomata the *x*-ray shows a deep shadow with irregular margins throughout the extent of the growth. One of the most characteristic features of the *x*-ray picture of the central sarcoma is the breaking through of the thinned cortex at various places by the sarcoma growing through it into the soft tissues.

8. Spontaneous fracture is a valuable sign in both the benign (osseous cysts) and malignant types of bone neoplasms. It may be the first symptom for which the patient consults the physician.

FIG. 490.—SKIAGRAPH OF SARCOMA OF LOWER END OF RADIUS (Dr. Dean D. Lewis' case).

9. In some osteosarcomata with large vascular spaces pulsation is so marked as to simulate an aneurysm.

In the differential diagnosis of osteosarcomata one must consider (*a*) tuberculosis of bone, (*b*) chronic abscess resulting from a former acute osteomyelitis, (*c*) simple or benign osseous cysts, (*d*) other forms of malignant bone neoplasms, such as myelomata, peri- and endotheliomata, and secondary carcinomata.

The chief differential points of the first three were enumerated under simple bone cysts (see page 683). The other forms of malignant neoplasms can only be differentiated from sarcoma by a consideration of the history of the case and the age of the patient. Carcinomata are always secondary to a primary growth in the thyroid, prostate, or breast, and occur at a late period of life.

Endo- and peritheliomata of bone occur after forty, as a rule, but do not differ clinically in other respects from the ordinary forms of sarcomata.

Myelomata cannot be differentiated from sarcomata clinically.

Other Forms of Malignant Bone Neoplasms.—In considering

the diagnosis of the nature of a malignant bone neoplasm one must not omit the following forms:

1. *Carcinoma.*—This usually occurs as a metastasis of a primary carcinoma of the breast, prostate, or thyroid. It occurs most frequently in the femur, and the primary tumor may have been overlooked until a spontaneous fracture occurs.

x-Ray in Carcinoma of Bone: The skiagraph of a carcinoma in a bone greatly resembles that of a central sarcoma. The bone structure shows extensive destruction and the shaft is greatly expanded. The medulla and cortex have lost all signs of demarcation, being replaced by a light area.

FIG. 491.—A CENTRAL SARCOMA OF UPPER END OF SHAFT OF LEFT HUMERUS (Rumpel).

Observe how completely the cortex has been eaten away and how the outline of the tumor extends far beyond the normal outline of the bone. This breaking through of the cortex by the tumor as seen in the *x*-ray is one of the most characteristic features that distinguish a central sarcoma from a bone cyst (see page 683).

2. *Myelomata* are composed of tissue which is similar to that of the red marrow of young bone. The tumor arises in the medulla of the bone, and on section looks like a freshly cut liver. It occurs oftenest in the tibia. Quite rarely the tumor is found in the lower end of the radius and ulna, upper end of the fibula and humerus, and lower end of the femur. The patients are young adults. The growth of the tumor and expansion of the bone take place very slowly, so that they behave more like the giant-celled central sarcomata.

Endo- and Peritheliomata of Bone.—About twenty-three cases[1] have been reported of this form of bone tumor, which can only be distinguished clinically from osteosarcoma by the fact that over seventy-three per cent. occur after the age of forty, while sarcoma is rare at that period of life.

[1] Howard and Crile: "Annals of Surgery," Sept., 1905.

DISEASES OF THE JOINTS IN GENERAL.

When the surgeon or physician is consulted by a patient suffering from some joint affection, the first question he asks himself is, *What is the nature of the condition?* In order to be able to systematically exclude one etiologic factor after the other, it is necessary to have some classification of joint diseases which shall serve as a working basis. In the light of our present knowledge the most satisfactory division is

FIG. 492.—SKIAGRAPH OF SARCOMA OF FEMUR (Rumpel[1]).

This x-ray is a good example of the variety of sarcoma which arises in the periphery of the medulla and extends through the periosteum. Note its excentric position.

into two great clinical groups, the acute and chronic. It is necessary, however, to state that there is often no hard and fast line between these two, since affections placed under one head will often present themselves clinically in such a form as to make it seem more appropriate to place them under the other. Until the etiology and pathology of chronic articular rheumatism and arthritis deformans is thoroughly investigated, no large grouping for these two affections will seem ap-

[1] A number of the skiagraphs of the various diseases and neoplasms were taken from the classical monograph by Rumpel in "Ergänzungs band x" of the "Fortschritte auf dem Gebiete der Roentgenstrahlen."

propriate. They are undoubtedly of infectious origin, but the exact nature of the latter is as yet undetermined.

A classification which will be found most useful from a diagnostic point of view is that suggested by König and will be employed here.

The general term "arthritis" is used in preference to that ot synovitis for some affections. Clinically the distinction cannot always be made between a case of synovitis and one of *arthritis*, since the same affection may at one time involve only the synovial membrane and, at another, all of the structures of the joint.

The classification is as follows:

ACUTE ARTHRITIS.

I. Primary acute arthritis.
   1. Acute traumatic.
   2. Acute articular rheumatism.
   3. Acute gout (described under gout).
II. Secondary acute arthritis.
   A. Metastatic arthritis.
      1. Through ordinary pus cocci, pyemic arthritis.
      2. Through other specific microörganisms.
         (*a*) Typhoidal arthritis.
         (*b*) Pneumococcus arthritis.
         (*c*) Influenzal arthritis.
         (*d*) Scarlatinal arthritis.
         (*e*) Gonorrheal arthritis.
         (*f*) Syphilitic arthritis (secondary stage).
   B. Secondary acute arthritis by extension.
      1. From an osteomyelitic focus (acute arthritis of infants).
      2. From the surrounding soft tissues (erysipelas, phlegmon, bursitis, tendo-vaginitis and lymphangitis).

CHRONIC ARTHRITIS.

I. Tuberculosis.
   1. Primary osteal.
   2. Primary synovial.
II. Chronic serous synovitis. (Chronic articular synovitis.)
III. Arthritis deformans.
IV. Chronic articular rheumatism.
V. Chronic and atypical gouty arthritis.
VI. Syphilitic arthritis.
VII. Neuropathic arthritis.
   (*a*) Tabes.
   (*b*) Syringomyelia.
VIII. Hemophiliac and scorbutic arthritis.
IX. Tumors of joints.
X. Hysterical joints.

In attempting to make a diagnosis of a joint affection, it is necessary to keep some such classification constantly in mind.

The examination should embrace the following:

1. An accurate history of the duration and mode of onset.
2. The general condition of the patient.
3. The examination of the affected joint or joints.

1. *History of the Case.*—If carefully taken, this will yield much information as to (*a*) the mode of onset, whether sudden or gradual;

(*b*) the relation of the joint affection to an injury either recent or at some period in the past history of the patient; (*c*) whether the affection accompanied some one of the systemic infections just enumerated; (*d*) whether it appeared after symptoms of a local infection had existed; (*e*) the family and personal history, as to hereditary or acquired diseases, habits, hemophilia, etc.

2. *The General Condition of the Patient.*—This embraces a thorough examination of the entire body, including temperature, pulse, condition of lungs, heart, and other viscera, and of the nervous system. Without such a general survey, a case of tabetic joint, for example, may be easily overlooked. Again, the existence of tuberculous foci elsewhere, will often throw great light on the nature of an obscure chronic joint affection. Evidence of cardiac or other serous membrane involvement is of great value in the diagnosis of rheumatic affections.

FIG. 493.—EXTERNAL VIEW OF PATIENT WITH PERIOSTEAL SARCOMA OF UPPER END OF FIBULA.
The arrow points to the greatly enlarged upper fibular region.

At times a therapeutic test is necessary, in order to establish a diagnosis of rheumatism or syphilis.

3. *Examination of the Joint.*—(*a*) Inspection reveals the presence or absence of swelling, deformity, redness, and edema of the overlying skin in more superficial joints, such as the ankle, knee, wrist, elbow, shoulder and sternoclavicular joints.

(*b*) Palpation shows the presence or absence of fluctuation, of localized or general tenderness, and of the degree of fixation of the joint.

(*c*) Exploratory puncture. This is a very valuable aid in ascertaining the character of the joint effusion, and must be performed with every possible regard for asepsis (see Fig. 494).

(*d*) X-ray. This gives much information in regard to the condition of the articular ends of the bones entering into the joint forma-

tion. In acute cases it is of little value; in chronic cases the changes are often slight or appear very late, especially in tuberculosis.

(*e*) Mensuration. The measurement of a joint and the comparison of the result obtained with that of the corresponding joints of the opposite limb is of great value in confirming other data.

The chief diagnostic features of the principal joint affections are as follows:

Acute Traumatic Arthritis.

This may follow (*a*) a blow over a joint or a fall upon a joint; (*b*) a distortion or twisting; (*c*) it may accompany a dislocation and, finally, (*d*) it occurs as the result of a fracture into the joint or in close proximity to it (see page 515). The history is usually quite clear. The injury is followed by severe pain over the joint and by loss of function. Within a few hours, there is noticeable swelling of the joint. It loses its normal contour, all of the depressions over it being effaced by the rapidly increasing swelling.

Exploratory puncture is rarely necessary for diagnostic purposes. If performed, the exudate will be found to be a clear, straw-colored fluid containing much albumin, more or less fibrin, and a few leukocytes.

As a rule, fever is not a diagnostic sign in an acute traumatic arthritis. There is, however, a rare possibility of the occurrence of a pyogenic infection of hematogenous origin, which will change the clinical picture. If this takes place, the pain and swelling will be excessive. The presence of such increased local signs, accompanied by constantly increasing leukocytosis and fever, speak for a secondary infection through the blood.

Another clinical fact is also of value, from a diagnostic point of view. A joint trauma may be followed by an acute gonorrheal arthritis in a patient suffering from a subacute gonorrheal urethritis. Such a case is not readily recognized unless it be borne in mind that infection of a traumatic arthritis although very rare may occur. If fever and other signs are present in such a joint, a search should be made for primary sources of pus, such as the urethra, etc.

Acute traumatic arthritis is also of interest on account of its sequelæ It usually disappears gradually, but may become chronic. The effusion either remains, or it disappears and recurs from time to time. In the former case, the disease is termed a *chronic serous synovitis* (see page 707). In the latter, *i. e.*, when it recurs, it is often given the special name *intermittent articular hydrops* (see page 707).

Among the other sequelæ of an acute traumatic arthritis or sprain

of a joint, may be mentioned a subluxation of the articular cartilage, the formation of free or floating bodies,[1] and finally the development of tuberculous foci in the joint itself or in the epiphyseal ends of the long bones in close proximity to it.

Acute Articular Rheumatism.

This form of joint affection is usually polyarticular but it may appear in a single joint and follow a trauma. Under the latter conditions, the clinical signs may be almost identical with those of a sprain.

The question can seldom be decided, without observing the rapid improvement following antirheumatic treatment (salicylates, etc.) and the fact that the rheumatic arthritis is accompanied by fever and profuse sweats.

Local examination of a rheumatic joint of the monarticular type also reveals greater tenderness over the affected joint, frequently accompanied by some degree of fever.

If the arthritis is polyarticular, the diagnosis is not difficult in the more acute forms. The joints are greatly swollen, and there is considerable edema of the periarticular tissues. There is also a variable degree of fever, usually from 101° to 104° F. The joint symptoms are frequently accompanied by sweats and evidences of involvement of the serous membranes, especially of the heart. The disease is also characterized by its tendency to wander from one joint to the other.

The greatest difficulty in both the monarticular and polyarticular forms is to differentiate them from other varieties of multiple joint infection. The latter are, as a rule, secondary to foci elsewhere, whereas in an acute rheumatism such primary foci cannot be found. The greatest difficulty is to differentiate a multiple gonorrheal joint invasion from that of an acute rheumatic form.

Another form of arthritis which may simulate the acute rheumatic form is the result of infection by contiguity from an adjacent osteomyelitic focus of suppuration in the epiphyseal ends of the long bones, such as the femur or tibia. In the more superficial joints, like the knee or shoulder, the more severe local signs, such as pain, tenderness, etc., will enable one to differentiate this form of acute arthritis. In deeply situated joints, like the hip, the diagnosis is more difficult. This form of acute septic arthritis occurs chiefly in children, and is accompanied by far graver symptoms of infection than is the case in an acute articular rheumatism.

[1] For a description of the diagnosis of these complications see Injuries of Joints on page 519.

In infants, such an acute osteomyelitis of the upper epiphysis of the femur with secondary arthritis of the hip causes high fever, severe pain on movement of the limb, flexion of the thigh upon the abdomen, and early abscess formation. In older children, there is also high fever, leukocytosis, delirium, much swelling, and marked local joint symptoms in cases of infectious arthritis due to adjacent suppurating foci. The presence of these localizing signs, the invasion of a single joint, and the more severe constitutional symptoms enable a differential diagnosis from an acute rheumatism to be made. The differentiation of gout, acute arthritis deformans, and acute forms of tuberculous arthritis will be considered under the respective heads.

Secondary Acute Arthritis.

As was stated on page 698, a primary purulent arthritis is very rare. Usually such an acute infectious joint disease is secondary to a more or less distinct primary focus. It is of the utmost importance to recognize this fact when called upon to make a diagnosis of an acute arthritis.

It is not always easy to state definitely the exact nature of the process.

1. The history should be carefully taken to ascertain (*a*) whether the joint affection followed one of the acute infectious diseases mentioned below; (*b*) whether it was preceded by an acute or a subacute gonorrheal process; (*c*) whether it followed a pyemia, and, finally, (*d*) whether it was preceded by evidences of infection in the bones forming the joint or in the soft tissues around the joint.

2. The examination of the exudate should be regarded as a more or less routine procedure in the diagnosis of this class of joint affections. This exudate is obtained by aspirating (Fig. 494) some of the fluid and examining it cytologically, as well as staining it for microörganisms and inoculating culture-media from it.

The exudate may often be sterile, or the organisms can only be demonstrated after repeated examinations.

Acute arthritis of this group may be secondary to one of the following:

1. To a pyemia or septicopyemia—staphylococcus aureus and streptococcus pyogenes infection.

2. To one of the acute infectious diseases—typhoid, pneumonia, influenza, scarlatina, gonorrhea. With the exception of scarlatina, the specific organisms of the respective diseases can at times be found.

3. Secondary to an acute osteomyelitic focus or to infection in the soft parts. Ordinary pyogenic cocci, unless the primary disease has been caused by other organisms, are usually found.

The clinical characteristics common to the majority of these cases of secondary acute infectious arthritis, are marked swelling, tenderness on palpation, pain on motion, loss of function, a variable degree of fever, leukocytosis, and more or less constitutional disturbances. The disease may affect a single joint or be polyarticular. The joints involved are seldom as exquisitely painful; there is also less tendency to a shifting about from one joint to another, and there is a higher degree of leukocytosis than in acute articular rheumatism.

Several of these forms of acute secondary arthritis require special mention.

FIG. 404.—METHOD OF PERFORMING EXPLORATORY PUNCTURE OF THE KNEE-JOINT.

The point of election is one situated to either side of the patella, preferably the outer, *e. g.*, point indicated in the illustration by the cross. The needle is inserted beneath the patella, which has been raised up by the fluid, and the piston gradually withdrawn.

Arthritis Secondary to Pus Foci Elsewhere (Pyemic).—This form occurs during the course of a general infection with the ordinary pyogenic organisms, viz., the staphylococcus aureus and the streptococcus pyogenes. When the joint affection is the direct result of a well-pronounced pyemia or septicopyemia it presents but little difficulty in diagnosis. The cases, however, in which the primary lesion was a furuncle or some other comparatively insignificant focus, such as a tonsillitis, otitis, etc., present far more difficulty. The exudate is always purulent, and contains the organisms which have caused the primary disease. Usually the disease is monarticular, the joint being greatly swollen and very painful. The local disease is accompanied by high fever and other septic symptoms. The paraarticular edema

is very marked, and perforation of the capsule, followed by extensive necrosis of the joint cartilage, occurs at an early stage.

Typhoidal Arthritis.—This is an infrequent complication of typhoid fever. The infection is seldom due to the typhoid bacillus alone. In the majority of cases it is a mixed infection, *i. e.*, in association with the ordinary pus cocci and the colon bacillus. The joint complications usually occur during convalescence, or even months or years after the attack. If it occurs during convalescence, the general symptoms are prolonged, and there is more or less fever. The local symptoms are not very severe, and the pain, swelling and tenderness are not marked.

The exudate may contain the typhoid bacillus alone. In the majority of cases the specific organism is mixed with staphylococci or colon bacilli. What has been previously stated as being true of all of the arthritides of secondary origin is true of this form, viz., that the joint exudate may be found sterile. The exudate can be either serous or purulent, and the disease may affect only one or several joints.

Pneumococcus Arthritis.—This form of arthritis may occur (*a*) as a direct complication of a pneumonia; (*b*) as a metastasis of a pneumococcus septicemia, or (*c*) as a purely local disease without any preceding pneumonia or any septic symptoms.

When the arthritis occurs as a complication of pneumonia it usually appears during the period of convalescence. The joint symptoms are quite marked. The pain varies in severity from a slight to a very severe one. Tenderness and swelling of the joint are very pronounced. Redness and widespread edema indicate an involvement of the periarticular tissues, and in some cases quoted by Herrick[1] an abscess was found in the structures about the articulation.

The lesion is usually monarticular, the knee-joint being most often involved. Exploratory aspiration of the joint effusion with bacteriologic examination of the fluid is the only means of recognizing the pneumococcic character of the disease. It must not be forgotten that an arthritis following a pneumonia, may be due to the ordinary pus cocci. The joint fluid may also be sterile at the time of the examination, so that repeated punctures should be made.

The constitutional symptoms show great variations (Herrick). In some cases, the joint symptoms are insignificant as compared with those involving the pleura, pericardium, meninges, or lung. In other cases the clinical picture is that of a severe septicemia, viz., high fever, dry tongue, rapid pulse, delirium, etc. In a third class of cases, the arthri-

[1] "American Journal of Medical Sciences," 1902.

tis is apparently primary, without pulmonary localization. This latter variety is the one which is often secondary to a pneumococcus osteomyelitis. The exudate is usually purulent.

Arthritis Following Other Infectious Diseases.—Pain, swelling, tenderness, and loss of function of a joint may appear during the course of a large number of other infectious diseases, *e. g.*, scarlatina, measles, diphtheria, dysentery, influenza, cerebrospinal meningitis, variola, and secondary syphilis. The diagnosis of the nature of the arthritis can only be made if there is a history of the primary disease. The arthritis may be monarticular or polyarticular. The exudate is usually serous, rarely sero-purulent.

Exploratory aspiration is rarely necessary in order to make a diagnosis.

Gonorrheal Arthritis.—This form of secondary arthritis presents such a varied clinical picture that its recognition often presents great difficulty.

Clinically and pathologically there are four forms:[1]

1. Hydrops. This is the mildest form. The arthritis is usually monarticular. The joint most often affected is the knee. If fever and general disturbances are present, they are slight. There is but little pain, and the loss of function is chiefly due to the swelling. The effusion is of a serous character, clear, and often of a greenish tint.

2 and 3. Serofibrinous and purulent forms. The symptoms are more intense. There is moderately high fever and tenderness, and the pain on movement is quite severe. The capsule is greatly thickened and there is more paraarticular involvement than in the serous form, so that ankylosis is not an infrequent sequela.

4. The phlegmonous form. This is the most virulent, and is often polyarticular. The local symptoms are best seen in superficial joints, like the ankle, wrist, or knee.

This fourth, is the most characteristic form of gonorrheal arthritis and occurs in adults as a complication of a urethritis. In children it frequently follows a vaginitis, but it may occur in male babies (Holt) without other clinical evidence of gonococcus infection.

It may involve only a single joint, but more frequently is polyarticular, representing a gonococcus pyemia.

The disease may begin suddenly with severe pain, swelling, tenderness, redness, and edema of the affected joint or joints. The general symptoms in such cases are extreme. There is but little fluid in

[1] I have followed the classification of König, which appears the most satisfactory.

the joint, the swelling and pain being the most marked local signs. In a few cases intraarticular abscesses form at an early period.

In children [1] the general symptoms are of a pyemic character with marked prostration.

After such an acute onset, the course of the case becomes very chronic, resulting in complete destruction of the joint, *i. e.*, its ligaments become lax, the cartilages are destroyed, and ankylosis follows.

Gonorrheal arthritis may run a subacute or chronic course from the onset. The patients often complain of flying pains in the joints. There is no swelling, but loss of function and ankylosis frequently follow.

The majority of cases of gonorrheal arthritis appear during the latter weeks of the acute stage of the disease. The condition also appears in the subacute or chronic cases.

There is usually no difficulty in making a diagnosis, even without a bacteriologic examination. The first step is to examine the urethra for pus, and the urine for clap shreds, and then stain these for the gonococcus. The only form of acute arthritis which requires differentiation, is articular rheumatism.

Both of these may begin as polyarticular lesions. Acute rheumatism is more apt to involve the smaller joints of the fingers or toes than is the gonorrheal form. In many cases the local signs are so similar in their severity as to make a differentiation impossible. The presence of a local gonorrheal infection should be sought for. If the gonococcus is found in the joint exudate, the diagnosis is confirmed. This latter is unfortunately technically a very difficult mode of diagnosis, and often results negatively.

Gonorrheal arthritis is more frequently monarticular than is the ordinary acute form; there is also an absence of cardiac or other serous complications in the gonorrheal form, and a greater tendency to early ankylosis.

In the more chronic forms of gonorrheal arthritis without much effusion and no tendency to ankylosis, the differentiation from chronic rheumatoid arthritis is very difficult. The most important point is to find the primary focus in the genito-urinary tract.

Secondary Acute Arthritis by Extension.—This form of acute arthritis occurs both in adults and children. The diagnosis presents no difficulty. Even in cases of this form of arthritis, following an acute osteomyelitis of the upper end of the femur or similar primary foci, the joint symptoms are so severe as to completely predominate the clinical picture.

[1] Holt: "Medical Record," March 11, 1905.

The exudate is usually purulent, and contains the same organisms as those which have produced the primary focus.

Such secondary forms of arthritis may follow (*a*) infection of the bones forming the joint (acute pyogenic osteomyelitis); (*b*) phlegmon or erysipelas, or even lymphangitis around the joint; (*c*) a suppurative bursitis or tenosynovitis in the vicinity of the joint, where such structures normally communicate with the articulation; (*d*) penetrating wounds or operations upon the joints. Clinically the picture is that of a severe arthritis accompanied by marked constitutional disturbances. The primary cause can usually be ascertained.

Chronic Arthritis.

Although the division into acute and chronic arthritis seems an unsatisfactory one from a pathologic standpoint, it appears to correspond in the majority of cases to the more important clinical signs, such as mode of onset, local findings, etc. We shall see, however, that some of the forms of arthritis which are usually spoken of as chronic, *i. e.*, slow and progressive in their course, begin quite acutely. For example, there is a group of cases of arthritis deformans, which have an acute onset and course, becoming gradually chronic. Similar exceptions are found in some of the other groups, such as the acute forms of tuberculous and gouty arthritis. These occur, however, rather infrequently, and with a little consideration of the chief diagnostic features of each individual case, they can generally be placed under one or the other heading.

Tuberculosis of Joints.—To this cause can be ascribed a large percentage of cases of chronic joint disease, and in the examination of such patients, especially in early life, this form of arthritis must always be thought of.

As in many other joint diseases a knowledge of the pathology is a most valuable adjunct in making a correct diagnosis. The disease may appear primarily (*a*) in the bone, called the primary osteal form, and then either invade the joint secondarily, or cause paraarticular abscesses without any involvement of the joint; or (*b*) its first manifestations are in the synovial membrane, called the primary synovial form, the bone being involved after erosion of the articular cartilage. In general, the primary synovial is more frequent than the primary osteal form. In the hip and elbow, the reverse is the case.

Clinically there are three forms, viz.:

(*a*) *A Tuberculous Hydrops.*—A slow accumulation of serous exudate takes place in this joint. Quite rarely, this form may pursue the acute

course just referred to, the clinical picture greatly resembling that of an acute rheumatic arthritis. Several joints may be involved with accompanying fever, pain, and swelling.

(*b*) *The Fungus Form.*—In this, there is a gradually increasing enlargement of the joint with pain, contractures, and slight increase of evening temperature.

(*c*) *Empyema of a Joint.*—In this the joint also enlarges slowly, and contains a considerable amount of tuberculous pus.

The chief diagnostic features of tuberculosis of the joints are as follows:

1. *Pain.*—This varies greatly, being often quite severe, while in other cases it is of a dull, aching character. The pain is usually referred by the patient to the joint involved, but it may be felt as in the case of a tuberculous hip-joint, in the knee. The pain is often more marked at night, the exacerbations causing patients to cry out in their sleep.

2. *Tenderness.*—This is a valuable sign, if found. It can, of course, only be elicited by pressure over the ends of the bones which form the more superficial joints, like the ankle, knee, fingers, wrist, elbow, and shoulder. When present, it indicates an osseous focus. In deep joints, like the hip, it can be elicited by tapping upon the knee (Fig. 514).

3. *Swelling.*—This is an early sign in primary synovial tuberculosis. In the primary osteal variety, it does not appear as early unless the disease progresses rapidly. The swelling is uniform (Fig. 522). All of the normal depressions disappear, and the muscles above and below the joint atrophy.

4. *Loss of Function and Rigidity.*—This is one of the earliest signs. The limitation of movement is marked in all directions, every movement being accompanied by pain. In a primary synovial lesion, the movements may at first be but little impaired and are painless. As soon, however, as the bone is involved, the limitations of motion and the pain become quite marked.

5. *Position of the Limb.*—This is often quite characteristic and varies with the stage of the disease and the individual joint involved. This symptom will be referred to in connection with the paragraphs upon tuberculosis of individual joints.

6. *Onset and Course.*—As a rule, joint tuberculosis begins insidiously, often weeks to months after a trauma. Its course varies according to the virulence of the disease and the treatment received. Deformities are a frequent sequel. The capsule may be perforated in one or more places and form *paraarticular abscesses*, which gradually reach the surface of the

limb and either form subcutaneous swellings, or the pus is evacuated, sinuses forming with typical tuberculous, bluish, undermined edges and lined by flabby, often caseous, granulations.

7. *Family and Personal History.*—It is of great importance in the diagnosis of joint tuberculosis to secure an accurate family history in order to ascertain, if possible, any hereditary tendency. In the same manner, information should be secured as to the presence of tuberculous lesions elsewhere, such as tuberculous cervical lymph-nodes (Fig. 511), or osseous, cutaneous or pulmonary foci. A pleurisy with effusion is often of tuberculous origin, especially if it recurs frequently.

8. *Temperature.*—As a rule, there is but little, if any, rise of temperature. If any exists, it occurs toward evening. At times one encounters cases with considerable fever. These are usually the result of a mixed infection.

9. *X-ray.*—The *x*-ray is of considerable value in the diagnosis of tuberculous lesions, but unfortunately it only gives positive information at a rather advanced stage. This is due to the fact that skiagraphs of a tuberculous joint will only show absence of normal shadow, *i. e.*, a defective clear area in the plate, when the bone itself has been affected. Its use will be referred to again in the diagnosis of tuberculosis of the individual joints. In very doubtful cases, a skiagraph should be made, since it will often aid in differentiating advanced tuberculosis from arthritis deformans and chronic rheumatoid arthritis, although even here there is a chance for error.

10. *Tuberculin Test.*—The diagnostic value of tuberculin has been the subject of considerable discussion of recent years, and will be fully discussed on page 828.

Differential Diagnosis.—Joint tuberculosis must be differentiated from a simple non-tuberculous joint effusion, from chronic gonorrheal and syphilitic arthritis, from chronic rheumatoid arthritis and arthritis deformans.

Chronic Serous Synovitis.—This usually begins acutely after an injury, and either persists, or disappears and recurs from time to time. It may, however, greatly resemble tuberculosis if it begins insidiously, causing a gradually increasing painless swelling of the joint. It is chiefly a disease of adults, so that it would rarely come into question in the diagnosis of joint disease in children. In adults, it most often affects the knee. There is an absence of bone tenderness, no limitation of motion, less pain, and less rigidity than in tuberculosis. The disease is not progressive; it tends to improve spontaneously. The hydrops often disap-

pears and recurs. There is no formation of paraarticular abscesses or sinuses.

Chronic Gonorrheal Arthritis.—In this form of arthritis, the history of an acute onset, and later becoming chronic, together with the finding of evidences of an old gonorrheal infection, are of great value. There is also a greater amount of paraarticular thickening, and more of a tendency to ankylosis at an earlier stage than is the case in tuberculosis.

Arthritis Deformans.—This disease must be considered from the fifteenth year on, especially in the elbow-joint. In this form of arthritis, the ends of the bones are palpably enlarged, and the capsule feels harder and firmer than in tuberculosis. Arthritis deformans also runs a much slower course, and is seldom accompanied by pain. It is also more apt to affect a number of joints.

Chronic Serous Synovitis (Chronic Articular Hydrops).—This form of chronic arthritis is usually the sequela or outgrowth of an acute arthritis. The most frequent cause is an injury, *i. e.*, a simple sprain or distortion of the joint. Koenig[1] has called attention to the frequency with which injury of the knee-joint may be followed by (*a*) the formation of joint mice, (*b*) isolated tears of the crucial ligaments, and (*c*) tears of the ligamenta alaria and the ligamentum mucosum. Any of these may be the cause of a serous effusion which may be more or less permanent or may disappear and then recur from time to time. If the villi arising from the ligamenta alaria or mucosum become enlarged, there may be only unsteadiness in gait, restricted motion, and severe pain without a serous effusion. The symptoms of joint mice without effusion are described on page 523. It may, however, appear in a gradual manner without any apparent cause. Where it directly follows an injury, the diagnosis is not so difficult. There is a history of injury followed by an acute swelling, which either persists or disappears, or recurs from time to time. To the latter clinical variety, the term *intermittent articular hydrops* is applied. It has also been called recurrent effusion.

Where the joint swelling has persisted after an injury, without free intervals, during which the exudate has disappeared, the condition may greatly resemble a synovial tuberculosis. In the latter, however, there is a greater amount of thickening of the capsule, and often a clear history of tuberculosis in the family, or foci to be found elsewhere in the body. The course of a chronic serous synovitis is more gradual, *i. e.*, it extends over a longer period. It is also characterized by an absence of fever, an almost painless course, only a slight crepitus, and an absence of pain on pressure.

[1] "Archiv für klinische Chirurgie," vols. lxxxi and lxxxii.

In the second form of chronic serous synovitis, *i. e.*, where it appears gradually without apparent cause, the diagnosis is even more difficult. The joint may be filled with papillomatous growths or converted into a lipoma arborescens.

In the majority of cases the disease involves the knee-joint, then the elbow, ankle, and wrist. The joints are more movable than those of

FIG. 405.—ANTERIOR VIEW OF A CASE OF ARTHRITIS DEFORMANS IN A BOY OF TEN (SAME AS SHOWN IN FIG. 406).

Note the characteristic rigidity and deformities of the wrists, elbows, fingers, and knees.

FIG. 406.—LATERAL VIEW OF CASE OF ARTHRITIS DEFORMANS IN A BOY OF TEN.

Note the enlargement of the lower end of the femur and the characteristic deformities in the elbow- and wrist-joints and in the fingers. The spine could not be extended further than is shown in the illustration, as a result of the same process.

chronic articular rheumatism, and there is no change in the cartilages and bones as in an arthritis deformans. There is a gradually increasing loss of function, and an accompanying accumulation of fluid.

Arthritis Deformans.—This form of chronic arthritis has been wrongly termed rheumatic gout, chronic rheumatic arthritis, rheumatoid arthritis, osteo-arthritis, dry arthritis and chronic articular rheumatism. We now know that it is a clinical entity characterized by a fibrous degenera-

tion in the synovial membranes and periarticular structures, as well as by atrophic and hypertrophic changes in the bone. It is most common in old age. According to some, it is of infectious origin, while others believe it to be the result of changes in the central nervous system.

There are five clinical forms, according to Osler and MacRae:[1]

1. *Heberden's Nodes.*—Nodosities develop gradually at the sides of the distal phalanges of the fingers about the thirtieth to the fortieth year. The larger joints are rarely involved, and the nodes seldom cause any symptoms.

FIG. 407.—DISLOCATION OF BOTH WRISTS DUE TO MARKED ARTHRITIS DEFORMANS.
The dislocation is more marked upon the right than upon the left side, and was of the forward variety. The characteristic deformity of the fingers is also present.

2. *Polyarticular or General Progressive Form.*—It may begin acutely with symptoms like an acute articular rheumatism. The chronic form is the more frequent, and the joints are involved symmetrically, usually those of the hands first, then the knees, hips, feet, and other articulations. There is a variable amount of pain. In some it is very severe, in others scarcely noticed. The pain is accompanied by more or less swelling of the joint. Creaking soon begins, followed by inability to move the joint owing to fibrous ankylosis. The muscles of the limb atrophy, and contractures of the joint set in (Fig. 498).

[1] "Journal of the American Medical Assn.," Jan. 2, 1904.

3. *The monarticular form* chiefly affects old people, and is seen particularly (Osler) in the hip, knee, spinal column, and shoulder-joint. In many the condition seems to directly follow an injury. The local signs and changes, viz., swelling, ankylosis, atrophy, and deformity, are the same as in the polyarticular form.

4. *Vertebral Form.*—The disease here causes a progressive ankylosis with resulting rigidity of the spine. It may be limited to one region or involve the entire spine, causing inability to flex or extend it. Pressure on the nerve-roots may cause great pain, paresthesia, and muscular atrophy.

FIG. 408.—MARKED DEFORMITIES OF THE FINGERS AND WRISTS IN A GIRL OF SIXTEEN DUE TO ARTHRITIS DEFORMANS.

5. *In Children and Young Individuals.*—The onset may be acute with fever or even chills, or gradual with increasing limitation of motion and enlargement of the joints. In the hip of children and young adults it produces outward rotation, adduction, and flexion similar to coxa vara, under which heading it will be considered.

In children this form of chronic arthritis is often characterized by general enlargement of the lymph-nodes and spleen, to which complex of symptoms the name *Still's disease* has been given.

There is more involvement of the synovial membrane and soft parts of the joint in children, and less destruction of bone and cartilage than in adults. **The diagnosis of arthritis deformans** is in general not difficult in the advanced stages. In the earlier period, especially in the acute cases, the diagnosis is more difficult. The chief forms of arthritis from which it must be differentiated are the following:

From Acute Articular Rheumatism.—The pain and swelling are usually more marked than in arthritis deformans. The disease rarely disappears in a joint to reappear in another one, a phenomenon so char-

acteristic of rheumatism. The spine and jaw are seldom involved in rheumatism. The enlargement of the lymph-glands speaks for arthritis deformans, as does the absence of cardiac involvement and the failure of the salicylates. There is also more rapid muscular atrophy, and the joint symptoms persist, even though the temperature falls in arthritis deformans.

From Gonorrheal Arthritis.—This may cause pain, swelling, stiffness, and be polyarticular. It should be excluded in every case (see page 702).

Chronic Articular Rheumatism.—This is characterized by the gradual onset of pain and swelling in the joints. The pain is very liable to exacerbations during changes in the weather. In some cases there is but little swelling or pain, the chief signs being stiffness and crepitation in the joints. The disease may be limited to a single joint, such as the shoulder, hip, or knee. There is never any erosion of cartilage or formation of new bone, as in arthritis deformans. The condition is often accompanied by valvular lesions.

Gouty Arthritis (Arthritis Urica, Podagra).—This form of joint disease may appear in (*a*) an acute, (*b*) a chronic, and (*c*) an atypical or irregular form. The chronic may be the outgrowth of the acute or appear gradually.

Acute Gout.—In this form there is a sudden onset of severe pain (usually at night) in the metatarso-phalangeal articulation of the great toe. The clinical picture is similar to that described as characteristic of other forms of acute arthritis, viz., severe pain, exquisite sensitiveness to pressure, redness of the overlying skin, fever, and swelling of the joint with obliteration of the normal depressions. The temperature may arise to 103° F.

The symptoms improve, only to recur from time to time. These acute attacks last about a week. Suppuration never occurs. After one or two attacks in one toe, the same joint of the other foot is apt to be affected; later it involves the ankle- or knee-joints.

The diagnosis usually presents no difficulties. The typical location of the acute joint swelling in a person who has been complaining of obscure pains all over the body, without gastro-intestinal disturbances, and has been a *bon vivant* or has led a sedentary life, should always lead to the suspicion of its being gouty in character. If the acute attack occurs primarily in other joints than those of the great toe, the diagnosis can only be made if *tophi* are found. These are collections of uric acid deposited in the external ear, the finger-joints, and later around the knee, elbow, etc. Another diagnostic point in favor of gout versus acute

rheumatic arthritis is the fact that the output of uric acid is greatly diminished during the attack. Fever is more constant in acute rheumatism than in gout. If limited to the metatarso-phalangeal joint of the great toe it must be differentiated from a bursitis (see page 646).

Chronic Gouty Arthritis.—This is either an outgrowth of the attacks of acute gout or may be primarily chronic. The toes, and later the fingers, ankles, knees, and elbows, gradually increase in size and become deformed. These enlargements are accompanied by deposits of uric acid around the affected joint capsule and in the ears. Ulceration of the skin over these tophi may occur. Accompanying these joint symptoms are often those of a chronic interstitial nephritis. These chronic cases can be differentiated from arthritis deformans and chronic rheumatism by the presence of tophi around the joints and in the ears, as well as by the constancy with which the acute attacks begin in the joints of the great toe.

FIG. 450.—TABETIC HIP-JOINTS.
Note the enormous enlargement of the gluteal region, due to increased size of the articular ends of the bone.

Atypical or Irregular Form.—This is a group of cutaneous, gastro-intestinal, cardiovascular, nervous, and urinary symptoms, which often accompany more chronic forms of gouty arthritis, or may occur independently of it.

Syphilitic Arthritis.—Acquired Syphilis.—(*a*) *Secondary Syphilitic Arthritis.*—Quite rarely an acute swelling, indicating an effusion into the larger joints, occurs during the secondary stage. It is characterized by pain and effusion in one or more of the larger joints. Usually the knee is the only joint involved. The diagnosis can be made from the fact that the arthritis appears almost simultaneously with the first cu-

taneous eruption, *i. e.*, about seven to eight weeks after the initial lesion. The joint swelling disappears rapidly after antisyphilitic treatment.

(*b*) *Tertiary or Chronic Syphilitic Arthritis.*—During this stage a form of arthritis occurs which is most difficult to recognize. It resembles a tuberculous arthritis so closely, that at times a differentiation can only be made by the administration of iodids and mercury or by opening the joint. In the latter case, one would see gummata in the synovial membrane or in the articular ends of the bone. The gummata are much larger and firmer than a tubercle, and are never caseated. If the disease is far advanced, ankylosis occurs, and antisyphilitic remedies produce no improvement.

FIG. 502.—CHARCOT KNEE-JOINTS.

The illustration shows a typical case of disease of the knee-joint occurring in tabes dorsalis or locomotor ataxia, to which the name arthropathie tabetique of Charcot has been given. Note the enormous enlargement of the lower ends of both femora, and the backward displacement of both tibiæ.

The history of a preceding syphilitic infection and the presence of evidences of the disease elsewhere, as well as the results of the therapeutic test, are the chief factors in making a diagnosis. The destruction of cartilage is seldom as extensive as in a tuberculosis and the tendency to deformity is far less marked than in tuberculosis. The absence of a primary focus of tuberculosis, or of a family history of this disease, will also aid in the diagnosis.

The arthritis referred to above is that due to the presence of primary gummata in the synovial membranes. Another form is that which is secondary to a gummatous osteomyelitis, and is not so

recognize, owing to the enlargement of the ends of the long bones preceding the arthritis.

The latter is most often found in the knee. Periarticular gummata also occur as localized tumors from hazelnut to walnut size, with but few subjective symptoms. It must be differentiated from the fibromatous form of tuberculous arthritis. Both of these conditions are very rare.

(*c*) *Arthritis in Hereditary Syphilis.*—This appears usually in a gradual manner, either with or without accompanying primary bone involvement. It most often affects the knees, but may involve the

FIG. 501.—ANTERIOR VIEW OF A TABETIC OR CHARCOT KNEE-JOINT, WHICH HAD BEEN DIAGNOSED A SARCOMA OF THE FEMUR.

This is the same case as shown in Figs. 502 and 503.

FIG. 502.—VIEW FROM RIGHT SIDE OF ENLARGEMENT OF THE LOWER END OF FEMUR AND KNEE-JOINT IN A CASE OF TABETIC ARTHRITIS.

Same case as shown in Figs. 501 and 503.

wrists and elbows. It seldom appears before the sixth year. There is considerable swelling and thickening of the capsule, the latter in the form which is secondary to bone disease. Nocturnal pains are complained of. The epiphysis is often enlarged and may be entirely separated from the shaft. The loss of function in such a joint often gives rise to a condition known as *pseudo-paralysis*. Pus formation is rare. The suspicion of hereditary syphilis should always be aroused if an apparently idiopathic, almost painless, spindle-shaped swelling of the larger joints, especially the knee or elbow, appears in a child, accompanied by loss of function of the arm or leg. The cornea,

teeth, skull, and other epiphyses should be examined, and a careful history of the family and the infant's previous eruptions, coryza, etc., should be inquired into. These joints improve rapidly after antisyphilitic treatment.

Neuropathic Arthritis.—This occurs so relatively often after middle life that the possibility of an obscure joint affection being either of tabetic or syringomelic origin must be constantly borne in mind.

These two forms of arthropathy, viz., those due to syringomyelia and to tabes, differ somewhat in their clinical appearance.

(*a*) *Arthritis Tabetica* (*Arthropathie Tabetique, Arthritis Neurogenica*).—The clinical history varies greatly. In some cases the joint swelling appeared suddenly after a slight injury, and has persisted in spite of all treatment. In other cases the onset of the swelling was gradual, and attracted the attention of the patient only when it became quite marked and was accompanied by deformity such as subluxation, or by loss of function due to laxity of the ligaments. The joints most frequently affected are the knee, hip, and ankle, in the order named. In any case of joint disease in middle-aged or old persons, in which there has been a rapid painless swelling of the joint, the possibility of tabes must be considered and a search for the classic symptoms made. These are so fully described in all of the text-books on internal medicine and neurology that it will only be necessary to mention the lightning-like pains along the back of the lower limbs, the absence of the patellar reflexes, the swaying of the body when standing erect with eyes closed, ataxic gait, the Argyll-Robertson pupils, the bladder and rectal paralysis, and finally the disturbances of cutaneous sensation.

FIG. 503.—TABETIC KNEE-JOINT.

The illustration shows the enormous enlargement of the lower end of the femur as a result of trophic disturbances and the ability to produce abnormal abduction in the knee-joint.

In the most typical cases, the knee or ankle is enormously enlarged, there is marked crepitus on manipulation, and the ends of the femur and tibia can be felt to be markedly enlarged. The latter may be so great that in the case shown in Fig. 503 the patient was referred to the

with the diagnosis of osteosarcoma of the lower end of the femur. Accompanying the joint swelling there is often a subluxation of one of the bones of the joint (Fig. 503). In many of the cases, the *painless abnormal mobility of the joint* is the most characteristic feature. This symptom and the rough crepitus are the chief factors in the diagnosis of tabetic disease of the hip-joint. The swelling may disappear entirely in some cases, and then recur from time to time. In other cases there is no

FIG. 504.—X RAY OF A TABETIC KNEE-JOINT.
Note the hypertrophic condition of the internal condyle of the femur which simulated a neoplasm.

swelling at any time, but a tendency to the formation of osteophytes in the joint capsule.

The principal forms of arthritis from which it must be differentiated are tuberculosis and arthritis deformans. In neither of these is the swelling as painless as in tabes.

Arthritis deformans often affects many joints, especially the smaller ones, and there is overgrowth of bone (hypertrophic form) with tendency to ankylosis. Tuberculosis is infrequent at the time of life when tabes

appears. The joint swelling is seldom as marked as in tabes, and the capsule is usually thicker. The swelling leads to more or less fixation of the joint in tuberculosis, and not to abnormal mobility as in tabes. The previous history of the two affections and the examination for the nervous symptoms of tabes will clear up any doubts.

(*b*) *Syringomyelia.*—This form of neuropathic arthritis differs from that of tabes in chiefly affecting the joints of the upper extremity. There are usually two forms: (*a*) As in tabes, there may be a sudden onset with joint swelling after an injury.

In other cases the swelling appears very slowly. In both instances the shoulder or elbow is most often affected. The swelling itself is enormous, and the abnormal mobility and rough crepitus on manipulation very marked.

FIG. 505.—SYRINGOMYELIC DISEASE OF THE ELBOW-JOINT (E. Graf).

(*b*) In the second form, the most striking feature is the tendency to recurrent dislocation, most often of the shoulder-joint. This may have appeared like the ordinary form of dislocation after an injury. The injury, however, is often of a trivial nature. Suspicion should be aroused in every such case, when the dislocation tends to recur upon the slightest amount of manipulation. This tendency to dislocation, accompanied by the enormous distention of the capsule, the painless course, and the rough grating sensation obtained on manipulation, should cause an examination for the other symptoms of syringomyelia to be made. These are the occurrence of painless infections about the fingers and an absence of temperature and pain sense, so that the patient will burn or freeze his fingers without being conscious of it.

In 80 per cent. of the cases of tabes the arthropathy is confined to the lower extremity, while in syringomyelia the same is true for the upper extremity. The clinical picture of both is similar (Figs. 503 and 505), viz., enormous swelling, relaxation of the capsule and ligament permitting of abnormal [redacted] or of complete or incom[redacted]

dislocations taking place. Fractures near the affected joint are more frequent in tabes. Both run an almost painless course.

Hemophiliac and Scorbutic Joints.—Both of these may appear in an acute and chronic manner.

The symptoms of both are practically the same, the chief difference being in the history of the case. In the acute form there is pain, fever, and marked swelling of the joint. These all disappear, but may recur. In less severe cases there is only moderate swelling and pain, but no fever.

FIG. 506.—VIEW OF CASE OF TUBERCULOSIS OF THE LEFT SHOULDER-JOINT SIDE, TO BE COMPARED WITH NORMAL SHOULDER SHOWN IN FIG. 507.

Note the atrophy of the deltoid from disuse, causing the acromio-clavicular articulation to become prominent; and also observe the fullness below the coracoid process, due to the thickening of the joint capsule, etc.

In the chronic form the joint has passed through a number of the acute or subacute attacks just described, but remains swollen with thickening of the capsule, evidences of fluctuations, and enlargement of the joint ends of the bones. Adhesions are often present, causing considerable impairment of mobility.

The joint lesions can seldom be diagnosed as accompanying a general or scorbutic condition, or as occurring as a part of a general tendency to hemorrhage (hemophilia), without an accurate history and the thorough examination of the body in general.

In the hemophiliac joints there is usually a previous history, or some other obstinate hemorrhage from slight causes. The patients are often pale and anemic. The aspiration of the joint effusion shows it to be pure blood. Since blood, even in microscopic quantities, is rarely observed in any other form of non-traumatic arthritis, its presence should lead one to suspect either hemophilia scorbutus, or a new growth.

In scurvy (scorbutus), there is usually a history of an absence of some normally necessary factor in the diet, whether it occur in children or adults.

In children, there is such marked soreness about the knees or ankles that they cry out with pain when lifted, and a condition of pseudo-paralysis results from inability to use the limbs. In adults, the joint swelling is the most marked feature, and there is pain over the affected tibia or femur. As in children, the knee- and ankle-joints are most often involved.

In both children and adults the most important diagnostic sign is the spongy, swollen, bleeding gums, a foul breath, and a tendency to subcutaneous hemorrhages.

Prompt improvement follows proper diet. Epistaxis is frequent in adults, and there is general anemia. The vast majority of hemorrhages occur in the knee, and most frequently in men. In purpura rheumatica the subcutaneous hemorrhages (Fig. 525) are usually a deciding factor, as is also the fact that many joints are usually involved.

In the chronic form a scorbutic or hemophiliac joint may resemble a tuberculous arthritis, but there is usually some rise of temperature in the latter (99° to 99.5° F. in the afternoon). The course of a tuberculosis is also more progressive, and there are never any sudden exacerbations or remissions. When ankylosis exists the differentiation from chronic rheumatic or tubercular joints is impossible, without a complete history.

Tumors of Joints.

These are very rare, and are chiefly benign in character, although a few cases of sarcomata of the larger joints (Fig. 485) have been observed. The most common of the benign forms are the joint lipomata first described by Volkmann in 1875.[1] These cases are true lipomata, usually developing beneath the synovial membrane, *i. e.*, extra-articular. They differ from a condition known as lipoma arborescens, in which there is an excessive deposit of fat in the normal joint villi. Both of the conditions just referred to occur most frequently in the knee-joint, but cases of its occurrence in the elbow and ankle have been described.

The tumor extends into the joint, either carrying the synovial membrane or breaking through the latter. The principal symptom in these cases is a painless enlargement of the joint. The swelling is soft and doughy.

Neuralgic or Hysterical Joints.

This form of joint affection is found in neurotic persons, and may simulate genuine disease. The conditions may follow an insignificant injury, usually of the hip or knee, but it may appear in any joint after an injury and be made the basis for damage suits. Any attempt at movement causes great pain.

[1] Biochitzky: "Beiträge [illegible]hirurgie," vol. xxiii.

The joint motions are apparently restricted in all directions, but if the patient's attention is diverted or if he is anesthetized, all limitation of movement disappears.

The joint is often swollen and sensitive, as well as fixed. Intermittent hydrops may occur in such joints. In cases of long duration there is some atrophy of the muscles above and below the joint (Figs. 516 and 517), as a result of non-use. There is seldom any rise of local temperature, but even this may exist.

Accompanying the joint symptoms are other signs of hysteria both in children and adults, and in men as well as in women.

DISEASES OF THE INDIVIDUAL JOINTS.

The clinical picture of both acute and chronic arthritis possesses certain variations according to the joint involved. These depend upon the relations of the capsule to the overlying parts, as well as upon the accessibility of the individual joint to direct manipulation. For example, the capsule of the knee-joint lies so close to the surface and extends over so great an area, that the recognition of changes both within and external to the joint is much easier than is the case with such articulations as the shoulder and hip. In the case of the shoulder but little of the capsule lies close to the surface, while in the hip, the depth of the joint prevents any direct recognition of changes.

It is therefore important to be able to search for certain clinical characteristics of each individual joint.

The following table may be of some assistance:

	Swelling First Appears.	Pain.	Most Characteristic Position.
Shoulder	Anteriorly between coracoid and head of humerus.	Over joint and along arm.	Adduction.
Elbow	On both sides of olecranon.	Over joint.	Flexed at acute or right angle.
Wrist	On dorsum.	Over joint.	Slight flexion.
Finger-joints	On dorsum.	Over joint.	Flexion.
Sacroiliac	On back of joint.	Over joint and along back of limb.	No change.
Hip	Invisible until later, then in front.	Over joint and to knee.	Varies according to stage (p. 513).
Knee	On all sides of patella.	Over joint.	Flexion, later subluxation of tibia.
Ankle	Over front of joint and below malleoli.	Over joint.	Flexion.
Tarsal joints	Invisible.	Over joint.	No change.
Toes	On dorsum.	Over joint.	Flexion.

SHOULDER-JOINT.

Acute arthritis, exclusive of the traumatic form, is infrequent in this articulation, and has no special characteristics. The most common forms of chronic inflammation are tuberculosis, rheumatism, arthritis deformans, and syringomyelia, as well as the various forms of post-traumatic ankylosis.

Tuberculosis of the shoulder-joint is a comparatively rare affection. It begins insidiously with pain on motion and there is a dull aching pain when the limb is at rest. The pain is often neuralgic in character, and is always worse at night. The shoulder appears fuller in front, between the coracoid and humerus, and there is usually marked atrophy of the deltoid, so that the acromion is quite prominent. The arm is adducted to the side of the body. Abduction, both active and passive, is difficult, and accompanied by pain. When suppuration occurs, the sinuses appear in the axilla and over the front and back of the joint. There is usually no difficulty in distinguishing a subdeltoid bursitis from an arthritis of the shoulder. The two may however coexist, especially in tuberculosis.

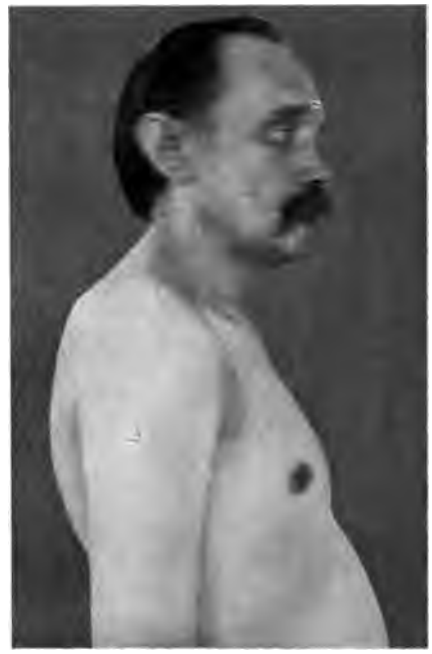


FIG. 507.—VIEW OF NORMAL RIGHT SHOULDER.

To be compared with Fig. 506. (Case of tuberculosis of the shoulder-joint.) Observe the depression below the coracoid process on the normal side, as compared with fullness on the diseased side.

ELBOW-JOINT.

The majority of forms of acute and chronic arthritis of this joint are accompanied by effusion and changes in the capsule. The swelling is most marked on either side of the olecranon process, and the early atrophy of the muscles of the arm and forearm gives the joint enlargement a spindle-shaped appearance. If the effusion is extensive, fluctuation may be easily elicited over the back of the joint is held rigid in

flexed position, either at a right or an acute angle. Pronation and supination are greatly limited. If the tuberculosis is limited to the head of the radius, there is marked absence of rotary power and localized swelling. Sinuses are most apt to be found upon the posterior and lateral aspects of the joint.

WRIST-JOINT.

This joint lies so superficially that but little effusion is required to obliterate the normal depression upon the back of the wrist. The

FIG. 508.—TUBERCULOSIS OF THE SHOULDER-JOINT, SHOWING THE LIMITATION OF MOTION ON THE DISEASED SIDE, AND CHARACTERISTIC ABDUCTION DEFORMITY.

On the normal side the arm could be raised up easily to the level of the head; on the diseased side it could only be voluntarily abducted from the body about forty-five degrees.

most common affection of the chronic variety is tuberculosis. In this there is swelling on the back of the wrist. The wrist-joint is stiff, and any movements are accompanied by pain. The hand is held flexed on the forearm. As in the case of the other joints, the degree of swelling can be estimated by comparing its circumference with the joint of the opposite limb.

FINGER-JOINTS.

These are frequently the seat of acute rheumatic arthritis and of gouty and chronic rheumatic arthritis, as well as of arthritis deformans.

Tuberculosis of the finger-joints may occur independently of an osseous focus, but is usually associated with the latter (Fig. 473). The swelling is always more distinct on the dorsum. In acute forms, the position is one of extension, while in the chronic forms, flexion and lateral deviation are more common.

Special attention must be called to a form of septic arthritis, caused by a bite, the teeth entering the metacarpo-phalangeal joints while they are flexed. They run a subacute course and are often overlooked, the case being treated as one of ordinary subcutaneous phlegmon.

FIG. 500.—ANTERIOR VIEW OF CASE OF TUBERCULOSIS OF THE SHOULDER-JOINT.

N, Normal shoulder-joint; T, tuberculous. Note the prominence of the diseased side.

SACROILIAC JOINTS.

Involvement of this joint occurs very rarely, and usually in young adults. Tuberculosis is practically the only form of disease of this joint.

Pain is felt by the patient over the articulation, which is often worse at night. The joint is also sensitive to pressure. The pain radiates down the thigh, and is increased when the patient sits down. The patient attempts to step as lightly as possible upon the toes of the diseased side, so that limping is quite marked and the pelvis compensatorily lowered. There is often swelling to be seen and felt posteriorly over the articulation. When the ilium is grasped on the diseased side and attempts made to move it, the pain in the joint is greatly increased. Abscesses open either posteriorly or burrow along the pelvic fascia to open in the lumbar or gluteal regions, in the ischiorectal fossa, or even in the inguinal region.

Disease of this articulation must be differentiated from [illegible] sciatica, from hip-joint disease [illegible] tuberculosis of the [illegible] bræ. It can be differenti[illegible]ago by the [illegible]

is higher up and is not localized, as in sacroiliac disease. In sciatica the predominant symptoms are pain over the sacrosciatic notch, which radiates down the back of the thigh and then into the foot. There is no tenderness over the sacroiliac joint, and the patient does not hold the pelvis rigid or cry out with pain when the ilia are pressed together.

From tuberculosis of the spine, sacroiliac disease can be distinguished by the fact that one or more of the spinous processes are prominent, and there is more marked reflex rigidity than is the case in sacroiliac disease when movement is attempted.

From coxitis it can be differentiated by the presence of rigidity, when attempts are made to carry out movements of the hip-joint. The pain is felt in the hip or knee, and not over the sacroiliac joint. In diseases of the latter joint, when the pelvis is fixed, all movements of the hip are free.

FIG. 510.—POSTERIOR VIEW OF CASE OF TUBERCULOSIS OF THE ELBOW-JOINT.

N, Normal arm; T, tuberculous. Note the characteristic obliteration of the depressions on either side of the olecranon process. (See Fig. 511.)

In advanced cases of hip-joint, sacroiliac, and Pott's disease, when many sinuses are present it is often impossible, before operation, to state the primary source of the pus.

DISEASES OF THE HIP-JOINT (COXITIS.)

Acute affections of this joint are infrequent. The acute arthritis following an osteomyelitis of the upper end of the femur in children has already been referred to (page 663) and will be taken up later under the head of differential diagnosis of tuberculosis of the hip. Acute arthritis of the joint occurs during all of the infectious diseases mentioned as causing arthritis (see page 695). The diagnosis in such cases can be made (*a*) from the history of the primary infection; (*b*) from the presence of severe pain referred to the hip or knee; (*c*) from the marked limitation of movement of the joint, the reflex muscular spasm causing almost absolute fixation; (*d*)

from the presence of fever and other signs of acute inflammatory reaction.

In some cases the patients are not seen during the acute stage of coxitis. The surgeon is consulted on account of a deformity resulting from it. This may be either in the shape of an ankylosis or of a dislocation. The diagnosis in either case rests upon the objective findings taken in conjunction with the previous history. Such apparently spontaneous dislocations following an acute coxitis have been reported after typhoid, scarlatina, acute rheumatism, influenza, etc.

FIG. 511.—TUBERCULOSIS OF THE ELBOW-JOINT.

Note the depressed scar in the supraclavicular region following an operation for tuberculous lymph-nodes of the neck. This was probably the primary infection, having preceded the elbow-joint disease by five years. (See text.) Observe the characteristic flexion of the elbow, which occurs in all diseases of the elbow-joint, the forearm and hand being held in a position of half supination and half pronation. Observe the prominence on the outer aspect of the elbow-joint, replacing the normal depression between the olecranon and the external condyle.

Another form of acute coxitis to be mentioned is that resulting from gonorrhea. As is the case in all of the forms of metastatic gonorrheal arthritis, there is an early tendency to marked ankylosis. It is most apt to occur in young adults.

The most important disease of the hip-joint is tuberculosis. It is the one from which the majority of the acute forms must be differentiated, both at the time of the onset and, if seen at a later period, after all of the acute symptoms have disappeared.

Tuberculosis of the Hip-joint (Tuberculous Coxitis).—The examination of a child for the purpose of making a diagn

this common affection should be conducted in a more or less systematic manner, as follows:

1. *Detailed history of the case.*

2. *Inspection.*—To determine (*a*) the presence of lameness; (*b*) the position in which the limb is held, *i. e.*, its attitude during walking, standing, or upon lying down.

3. *Palpation.*—To determine (*a*) whether there is fixation of the joint, *i. e.*, limitation of its normal movements; (*b*) whether any swelling is present; (*c*) whether tapping upon the trochanter or knee causes pain.

4. *Measurement.*—To determine the presence of muscular atrophy and of shortening.

5. *X-ray examination.*

FIG. 512.—APPEARANCE OF HANDS IN ACUTE RHEUMATIC POLYARTICULAR ARTHRITIS.

1. **History.**—This should include not only the mode of onset, but also whether there is any tuberculosis in the family, or evidences of recent or old foci elsewhere in the patient. The usual history of the mode of onset is that it has been gradual.

In but few cases does the disease begin suddenly. There is not infrequently the history of a fall upon the trochanter or of other injury to the limb. The first symptom noticed by the parents is that the child begins to limp, and the hip is held a little rigid. In addition the child complains of pain in the hip or in the knee, which is increased by any movement of the affected limb. Often these pains are increased at night, so that the child awakens from a sound sleep with an outcry of sudden pain. Intelligent parents will often give such a history of gradually increasing lameness, stiffness of the hip, and pain that the attention of the surgeon is at once attracted to this joint.

2. **Inspection of the Limb.**—This will give much information, and the child should be thus examined, if possible while standing, walking, and lying down, being stripped of all superfluous clothing.

The child is seen to limp, resting as little weight as possible upon the toes of the diseased limb. The pelvis is elevated upon this side, so that the limb appears shortened. When the two anterior superior spines are outlined on the skin, this compensatory tilting of the pelvis can be well seen. Inspection will further reveal any changes in the attitude of the limb. This is a very common and prominent symptom, and is due to the reflex muscular spasm. It is inadvisable to divide tuberculous coxitis into three stages according to the position of the limb,

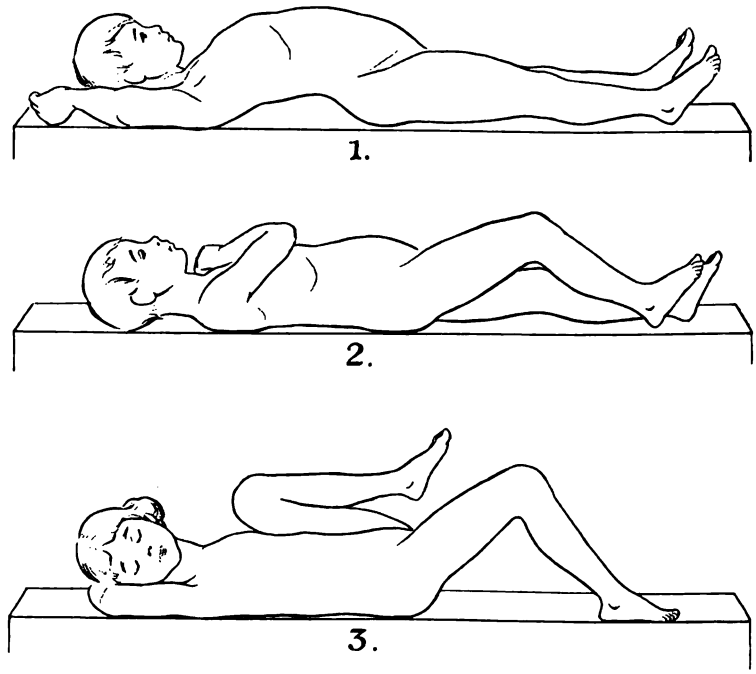


FIG. 513.—VARIOUS POSITIONS IN HIP-JOINT DISEASE (Edmund Owen).

1, Compensatory lordosis in hip-joint disease; 2, method of estimating degree of flexion of the hip, when back touches table; 3, amount of fixation of hip-joint. The normal left limb can be flexed upon the abdomen; the diseased limb forms the angle shown in the figure.

for the reason that these are so inconstant as to lead to much confusion. This is especially true of the early stage. In the early period the limb is usually abducted and rotated outward, but not always flexed. In the later stages the attitude of the limb is far more uniform. At such time there is marked adduction, internal rotation, and flexion. The limb in the early stages appears to be shortened, but, as has just been explained, this is the result of tilting of the pelvis. In the later stages the shortening of the limb is genuine, due to actual loss of bone substance.

Abduction of the limb causes the pelvis to be raised, while adduction results in its being lowered. The flexion of the joint causes a compensatory lordosis, and the degree of flexion can be readily estimated.

3. **Palpation for Limitation of Motion, Location of Pain, and Swelling.**—Palpation yields much information of diagnostic value. The child should be laid upon a firm couch or table and the range of motion upon the healthy side first ascertained, as this will often clear up the question as to whether any rigidity is due to the child being frightened.

FIG. 514.—METHOD OF TAPPING KNEE TO DETERMINE TENDERNESS IN CASES OF SUSPECTED HIP-JOINT DISEASE.

The patient's knee-joint region is allowed to rest upon the surgeon's left or right hand, as the case may be, while the opposite hand taps upon the region of the patella.

The suspected limb should be held at the knee with one hand while the other grasps the pelvis close to the hip (Fig. 386). The examination should determine whether there is any limitation of abduction or adduction of the limb. When this movement is limited, the pelvis moves with the diseased limb. The degree of flexion can either be determined while the patient is lying upon the back (Fig. 513) or upon the abdomen. Under normal conditions a child lying upon its back shows only a slight amount of lordosis of the lumbar portion of the spinal column (Fig. 513) when the limb is fully extended.

In hip-joint disease, a marked lordosis will appear (Fig. 513) when attempts are made to extend the limb. The degree of flexion can be roughly determined by allowing the lumbar spine (Fig. 513) to touch the table. Such a test cannot be used where much pain exists. If the patient lies upon the abdomen the amount of flexion can be determined by placing the hand upon the sacrum and alternately raising the affected and the normal limb. In case there is limitation of inward and outward rotation, the thigh is flexed to a right angle while one hand grasps the knee. Efforts are then made to turn the femur outward and inward. In the early stage of hip-joint disease, the motions which are limited are abduction, hyperextension, and rotation. In the later stage, the motions are limited in all directions.

FIG. 515.—NORMAL DEGREE OF LORDOSIS OF SPINE.
Note the slight forward curvature in lumbar region of a child lying in normal supine position.

Location of Pain.—Palpation is also utilized to determine the presence of pain and of swelling. Referred pain, however, may not be present at any stage of the disease, and is not nearly so valuable a diagnostic sign as the others mentioned here. When present, pain is usually felt on the inner side of the thigh, close to the knee-joint. Pain in the joint itself is less constant. There is often sensitiveness to pressure over the trochanter and when the knee is gently tapped (Fig. 514). Pain is also quite marked upon pressing deeply over the front and back of the joint.

Swelling.—There is often a distinct thickening to be felt over the head of the femur at Scarpa's triangle or behind the trochanter. This sign is very difficult to elicit, especially in the more acute cases. There is often an enlargement of the inguinal glands below Poupart's ligament.

Abscesses usually appear over the front of the joint, but may gravitate toward the trochanter or downward toward the knee. Similarly, sinuses may be present at any point.

4. **Measurements of the Limb for Shortening and Atrophy.**—The apparent shortening referred to, as existing in the early stages can be ascertained by the methods of measurement of the limb as described on page 567. Later in the disease, this same measurement reveals an actual shortening, varying according to the amount of destruction of the head and neck.

The presence of atrophy even at an early stage is a diagnostic sign of considerable value in this disease. The degree of muscular atrophy is ascertained by measuring the circumference of both limbs at the middle of the thighs (Fig. 516) and middle of the legs (Fig. 517).

FIG. 516.—METHOD OF DETERMINING THE CIRCUMFERENCE OF THE THIGH AT ITS MIDDLE. (See text.)

In the later stages a rectal examination should never be omitted, for evidences of perforation of the acetabulum, with resultant intrapelvic inflammatory induration and abscess formation.

5. **X-ray Examination.**—As was stated in the consideration of the diagnosis of joint diseases in general, this mode of examination can only be utilized at such a late period in tuberculous arthritis, that a diagnosis is possible in the majority of cases without it. This is especially true of the hip-joint, where the destruction of bone must be fairly extensive before it will show in a skiagraph.

Differential Diagnosis.—1. *Pott's Disease (Tuberculous Spondylitis).*—A tuberculous lumbar spondylitis may greatly resemble hip-

joint disease, owing to the limb being held in a rigidly flexed position. There is, however, no limitation of the motions of rotation, abduction, or adduction of the hip. When attempts are made to extend the hip no compensatory lordosis appears, the spine being held rigid. This latter symptom of spondylitis is more distinctly brought out when the child is asked to sit up, after lying upon the back. It will employ every effort to raise and support itself by the use of the hands, in order to keep the inflamed lumbar spine rigid. The pains are referred to the spine or along the lower abdominal nerves, and are usually symmetrical.

2. *Chronic Arthritis Deformans* (*Morbus Coxæ Senilis*).—This might come into question in elderly patients more often than in children,

FIG. 517.—METHOD OF MEASURING THE CIRCUMFERENCE OF THE LOWER LIMB AT THE LEVEL OF THE MIDDLE OF THE CALF. (See text.)

in whom it is infrequent. There is marked crepitation when the hip is rotated. The movements are only slightly limited. The *x*-ray would show bony hypertrophy.

3. *Acute Osteomyelitis of the Upper End of the Femur.*—The pain is far more acute than in tuberculous coxitis, there is high fever, and much swelling about the hip. There are other signs of general infection, such as a rapid pulse, leukocytosis, and often delirium. The destruction of the bone is rapid, and abscess formation and shortening occur at an early period.

4. *Rheumatic and Other Forms of Primary and Secondary Arthritis.*—In these the history of the previous infection is of the utmost importance, since the symptoms greatly resemble those of tuberculous coxitis. They can be distinguished from the latter only by their shorter course and the previous history.

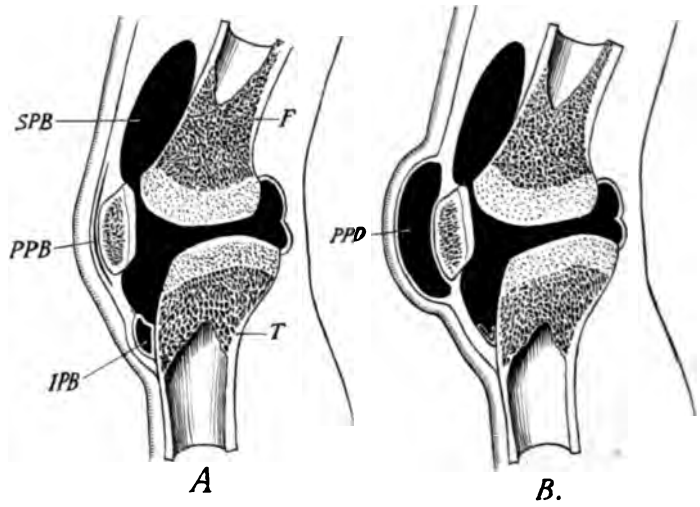


FIG. 518.—LOCATION OF VARIOUS COLLECTIONS OF FLUID IN THE VICINITY OF THE KNEE-JOINT.

A, Effusion into the knee-joint, and suprapatellar bursa: *F*, Femur; *T*, tibia; *SPB*, suprapatellar bursa *PPB*, location of prepatellar bursa; *IPB*, intrapatellar bursa. *B*, This illustration shows the simultaneous collection of fluid in the prepatellar bursa (*PPD*), and within the knee-joint itself.

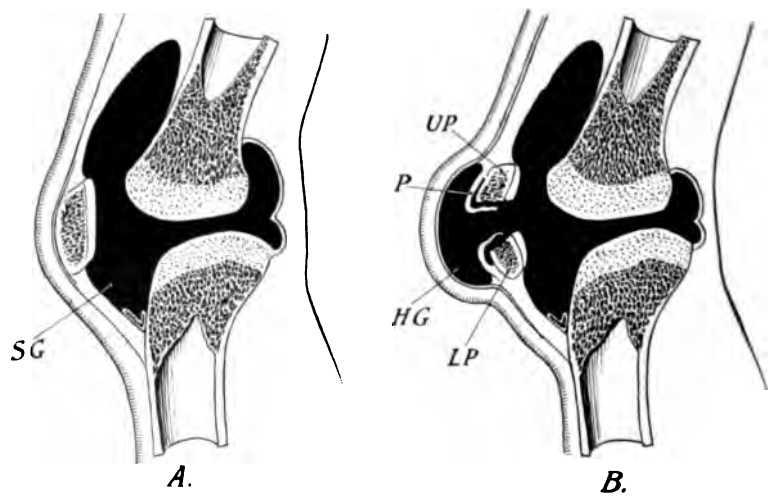


FIG. 519.

A, Sagittal section (diagrammatic) of knee joint to show distention of synovial sac (*SG*) with fluid. Note the distended suprapatellar bursa. *B*, Sagittal section of knee joint (diagrammatic) in a case of transverse fracture of the patella: *UP*, Upper fragment drawn upward by action of quadriceps extensor tendon; note how periosteum (*Po*) is turned inward, covering end of fragment; *LP*, lower fragment; *HG*, prepatellar swelling due to hemorrhage under skin communicating with bloody fluid distending joint cavity.

5. *Coxa Vara.*—The differential diagnosis of this affection is considered on page 745.

6. *Neoplasms of the Head of the Femur.*—Both carcinoma and sarcoma of distant organs may be followed by metastatic deposits in the head of the femur and simulate tuberculous coxitis, on account of the pain, rigidity, swelling, and shortening. In the case shown in Fig. 488 there was also evening rise of temperature. The diagnosis rests upon an accurate previous history, the examination of the remainder of the body for primary growths, and the *x*-ray.

7. *Inflammation of the Iliopsoas Bursa.*—This may also cause abduction, outward rotation, and flexion of the thigh, as well as pain radiating to the knee. Adduction and inward rotation are impossible without an anesthetic, while abduction and outward rotation are free. The swelling over the joint is more marked than in coxitis, and deep fluctuation can often be obtained.

FIG. 520.—SIDE VIEW OF KNEE-JOINT IN A CASE OF ACUTE SYNOVITIS.

The arrows point to the spaces above and below the patella, which are depressions in the normal knee-joint, becoming obliterated and bulging as soon as fluid collects in the knee-joint.

Abscesses of this bursa may rupture into the hip-joint and vice versa.

8. *Infection of the Deep Iliac Lymph-nodes.*—In a recent case of the authors, infection of these nodes followed a burn of the foot, and the thigh was firmly flexed upon the abdomen as in a disease of the hip-joint or disease of the spine. There was, however, no limitation of motion in the hip and no pain on pressure. There was also an absence of rigidity of the spine and on deep palpation the inflamed nodes could be felt in the iliac fossa.

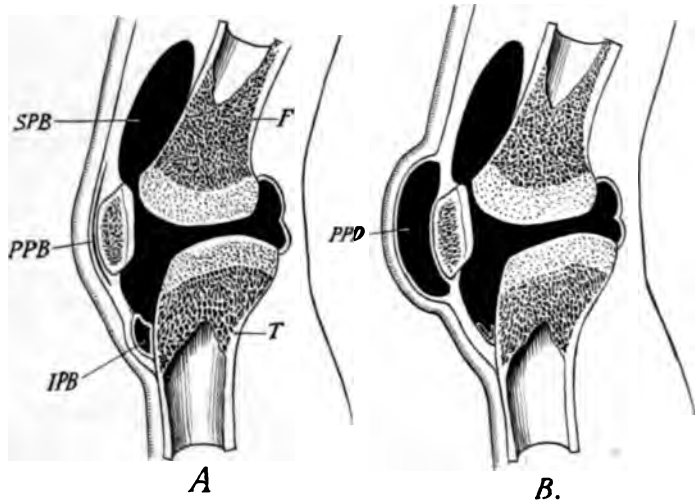


FIG. 518.—LOCATION OF VARIOUS COLLECTIONS OF FLUID IN THE VICINITY OF THE KNEE-JOINT.

A, Effusion into the knee-joint, and suprapatellar bursa: *F*, Femur; *T*, tibia; *SPB*, suprapatellar bursa *PPB*, location of prepatellar bursa; *IPB*, intrapatellar bursa. *B*, This illustration shows the simultaneous collection of fluid in the prepatellar bursa (*PPD*), and within the knee-joint itself.

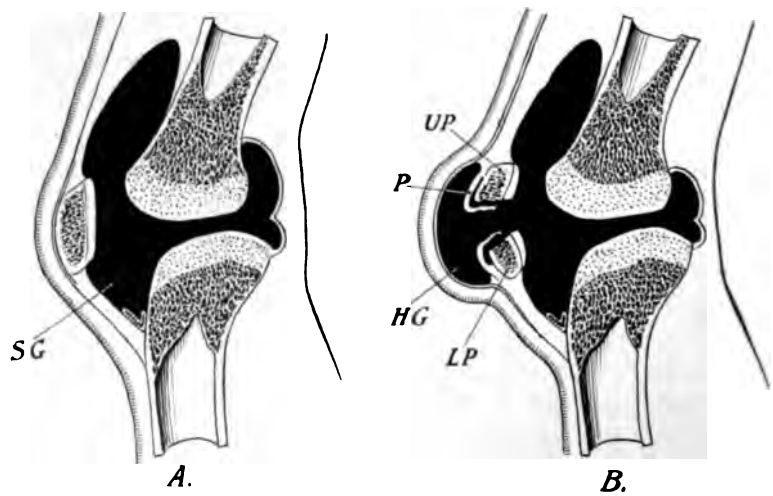


FIG. 519.

A, Sagittal section (diagrammatic) of knee-joint to show distention of synovial sac (*SG*) with fluid. Note the distended suprapatellar bursa. *B*, Sagittal section of knee joint (diagrammatic) in a case of transverse fracture of the patella: *UP*, Upper fragment drawn upward by action of quadriceps extensor tendon; note how periosteum (*P*) is turned inward, covering end of fragment; *LP*, lower fragment; *HG*, prepatellar swelling due to hemorrhage under skin communicating with bloody fluid distending joint cavity.

DISEASES OF THE KNEE-JOINT.

No joint of the body is more frequently the seat of the various forms of acute and chronic arthritis than the knee. It will be unnecessary to repeat the chief diagnostic points of these affections, since in every case one must make the diagnosis by the process of exclusion outlined in the discussion of joint diseases in general. The local signs vary according to the nature of the process, *i. e.*, whether it be acute or chronic, and again whether the effusion be serous, seropurulent, hemorrhagic, or purulent.

FIG. 771.—METHOD OF DETERMINING THE PRESENCE OF FLUID IN THE KNEE-JOINT, BY BALLOTTEMENT OR DANCING OF THE PATELLA ON THE UNDERLYING FLUID.

Two fingers are placed at the upper level of the patella and two at the lower, and alternately pressure is made. The patella can then be felt to be pushed back and forward, springing back, as it were, like a solid body when it is pressed upon while lying in water.

The following signs are common to the majority of the acute and chronic processes:

1. Pain in the knee and tenderness on pressure, especially along the lines of reduplication of the capsule.

2. Obliteration of the depressions on all sides of the patella. This may either be due to the presence of fluid in the joint itself or in the subcrural bursa, or it may be the result of thickening of the capsule or of a periarticular infiltration.

3. Ballottement of the patella. This is to be found if only a small quantity of fluid be present. It is elicited either by tapping lightly on

the patella or by placing the index-fingers upon it and exerting pressure. With either method the patella springs back again when the pressure is relieved. Fluid in the prepatellar bursa causes fluctuation in front of the patella, and the latter cannot be made to dance upon the fluid as is the case with an intraarticular effusion. In addition to this sign, the prominence is only over the patella, and there is but little, if any, obliteration of the normal depressions around the patella (Fig. 522).

4. The position or attitude of the limb. The knee in the more acute cases is held rigidly extended at first, but gradually flexion takes place. As the cartilages become eroded and the ligaments relaxed various deformities occur. These may be (*a*) extreme flexion; (*b*) subluxation of the tibia (Fig. 524); (*c*) genu valgum or genu varum, or even genu recurvatum, *i. e.*, backward curvature or hyperextension.

5. Manipulation of the limb may reveal crepitus, either due to adhesions or fibrinous deposits or to erosion of cartilage. It may also show relaxation of the ligaments (Fig. 397) or enlargement of the articular ends of the bones.

6. In the acute and chronic suppurative processes, sinuses may form on all sides of the joint and lead by a tortuous route to the inside of the capsule.

FIG. 522.—ANTERIOR VIEW OF A CASE OF ADVANCED TUBERCULOSIS OF THE KNEE-JOINT (LEFT)

Observe how the depressions normally existing on all sides of the patella have been obliterated, especially that above the patella corresponding to the seat of the suprapatellar bursa.

The most frequent form of inflammation of the knee-joint or gonitis is the tuberculous, and brief reference must be made to its chief diagnostic features.

Tuberculosis of the Knee-joint (Tuberculous Gonitis).—This may occur in those who are enjoying apparently the best of health, as well as in those who have marked evidence of tuberculosis elsewhere. Some cases apparently follow a trauma. In the majority of cases, however, such an injury is a very remote one, and has little to do with the development of the process. The more important symptoms of diagnostic value are swelling of the joint, tenderness on pressure, pain, fixation, atrophy, local heat, and, later in the disease, deformities.

1. *Swelling.*—This is usually most marked on either side of the patella. When muscular atrophy of the thigh and leg takes place the limb assumes a typical spindle shape (Fig. 522). The swelling has a semifluctuating or elastic consistency, due to the granulations within the joint and to the infiltration of the capsule and periarticular tissues. It is the action of the latter upon the overlying skin, causing it to be glazed and anemic, which gave this form of tuberculosis the old term of "tumor albus."

If the joint contain either a serous or purulent effusion as the result of the tuberculous process, there is more distinct fluctuation, the space above the patella is filled out, and the patella itself shows the phenomenon of ballottement. If such a joint effusion recurs from time to time and exploratory puncture shows it to consist of fibrin or to contain rice bodies it should be regarded as strongly suspicious of tuberculosis. In some cases the diagnosis may be made if a palpable thickening of the capsule remains after the fluid has disappeared.

FIG. 523.—LATERAL VIEW OF SAME PATIENT SHOWN IN FIG. 522.

Illustrating the characteristic flexion deformity, and the prominence of the suprapatellar bursæ.

2. *Pain, Tenderness, and Local Heat.*—There is but little pain, except in the more acute cases, and the same is true of local heat. Tenderness is present especially over the upper end of the tibia. The more acute the process, the more marked are the local pain, heat, and tenderness.

3. *Rigidity, Atrophy, and Deformity.*—The patient walks with a decided limp, the knee being held rigid. The muscular fixation is not so great as in the hip-joint, and many cases permit of quite free manipulation. Muscular atrophy appears early and is usually quite marked. The position is at first that of mild flexion, the leg being rotated slightly outward. As the process advances the flexion deformity becomes more marked and may be accompanied by subluxation of the tibia, the latter lying in a plane behind that of the femur (Fig. 524). An enlargement of the lower end of the femur and a genu valgum position is also frequently found in advanced cases.

4. *Abscess, Sinus Formation, and Fever.*—As a rule, there is only a slight rise of the evening temperature, 99° to 100° F., but in some cases, the formation of pus not only manifests itself by an increase in severity of the local symptoms, but also by a considerable rise in the general temperature, at times to 103°. In such cases one often questions the possibility of the process being of a tuberculous nature without the history of its gradual onset, the presence of the disease elsewhere in the patient himself or in his family, and lastly the fact that the capsule feels much thicker than is the case in an ordinary acute arthritis.

Abscess formation may also occur from extraarticular foci. These

FIG. 524.—CHARACTERISTIC FLEXION DEFORMITY IN A CHILD SUFFERING FROM TUBERCULOSIS OF THE RIGHT KNEE-JOINT.

Note the swelling above and below the patella, and the absence of normal depressions.

are usually found as quite localized, distinctly fluctuating swelling over the tibia or one of the condyles. Sinuses may be present on all sides of the joint.

5. *X*-ray shows erosions of cartilage and foci in bones.

Differential Diagnosis.—1. From some of the acute forms of arthritis. The resemblance of some cases of acute pus formation in tuberculous knees to other forms of acute arthritis has just been referred to. Of these latter there are some which require special mention, viz., acute gonorrheal or gonitis, the acute forms of hemophiliac gonitis, and some cases of monarticular acute rheumatism (Fig. 525). These can only be differentiated by the history of gradual development in tuber-

culosis, followed by acute symptoms. In the gonorrheal form the history and local examination of the urethra will clear up the diagnosis. In the hemophiliac arthritis there is not so much pain or tenderness or fever, and exploratory puncture reveals blood. The history will also be of the greatest aid. The monarticular rheumatic arthritis yields readily to appropriate treatment and is at times accompanied by a purpuric skin eruption (Fig. 525).

Both in children and adults a swelling of the knee-joint may persist for a long time after an injury. It may disappear and then recur as described on page 706, the question often arising as to whether the process is a tuberculous one. In children, effusions which persist for a considerable period after an injury, must be looked upon with suspicion. In adults such a chronic, often recurrent effusion, if tuberculous, is apt to be accompanied by the capsular thickening and other signs just described.

FIG. 525.—PURPURA RHEUMATICA ASSOCIATED WITH ENLARGEMENT OF THE LEFT KNEE-JOINT OF A RHEUMATIC NATURE.

Other conditions which must be considered in the differential diagnosis are arthritis deformans, tabetic arthropathy, sarcoma of the femur and tibia, lipomata of the joint and hysterical joints, as well as diseases of the periarticular bursæ (page 646).

DISEASES OF THE ANKLE-JOINT.

The acute forms of arthritis require no special mention, the most frequent of these being due to acute rheumatism, gonorrhea, and to trauma. Of the chronic forms those due to tuberculosis and tabes are of chief interest. The tabetic joints occur frequently enough in middle life to lead to errors in diagnosis. The local signs of the disease, viz., enormous enlargement of the joint, abnormal mobility in all direc-

tions, without pain and marked crepitation, combined with the more general evidences of tabes, serve to make the diagnosis comparatively easy.

Tuberculosis of the Ankle-joint.—1. Swelling. As in all effusions into the ankle the first evidences are seen by a fullness of the depressions over the front and later along the lateral aspects (below the malleoli and behind the joint). The swelling has the same elastic consistency as in diseases of the knee-joint, soon giving rise to the typical spindle-like shape, through atrophy of the leg muscles.

2. Gait and position of foot. The patient walks very lame, the foot is held in an extended and somewhat adducted position. The ankle is held rigid.

3. Pain and tenderness. Pain is present at an early stage and causes marked lameness, so that the patient steps very lightly on the diseased foot. There is tenderness on pressure over the entire joint. Attempts at movement of the joint and pressure of the foot against the leg cause great pain.

FIG. 526.—DOUBLE CONGENITAL DISLOCATION OF HIP (from a photograph in the collection of Dr. J. E. Moore).

Differential Diagnosis.—The principal conditions from which tuberculosis of the ankle-joint must be differentiated are the chronic forms of arthritis of this joint following injury and tuberculosis of the tarsal joints. In the chronic traumatic form there is an absence of the peculiar boggy elastic swelling, there is much less pain, and if tenderness is present, it is not so diffuse.

Tuberculosis of the Tarsal Joints (Medio-tarsal and Tarso-tarsal).—In many cases if sinuses are present and the foot is uniformly swollen a differentiation is impossible. In general, however, the pain, tenderness and swelling are in the anterior and middle portions of the foot and over the particular joint involved, while the movements of the ankle-joint proper are free and painless.

3. The limb is shortened, as compared with its fellow, in unilateral dislocations. This varies from 1 to 3 cm. in children one to two years of age to 8 cm. in older ones.

4. On deep palpation one can usually feel the head of the femur upon the dorsum ilii. This is best done when the child lies upon its back and the limb is rotated with one hand, while the other grasps the head. The head can be pulled down by traction upon the limb.

5. The Trendelenburg sign. When a normal child stands upon either limb and flexes the other at the knee and thigh, the opposite buttock will not be seen to drop. In the child with congenital dislocation, however, the opposite healthy buttock will be seen to drop when the child stands upon the affected limb so that the gluteal fold is at a lower level. This is due to the fact that the gluteal muscles upon the dislocated side are unable to perform their function of keeping the pelvis level.

6. There is a marked lordosis and scoliosis toward the affected side. If the lesion is bilateral the lordosis is very striking.

7. The *x*-ray examination is of great value, especially in young infants who are quite fat, the head and trochanter being difficult to palpate (Fig. 527).

Differential Diagnosis.—*Coxa Vara* (see page 743).—In this affection the head cannot be felt in an abnormal position. It resembles congenital dislocation in the fact that the limb is shortened and that the trochanter lies above the Roser-Nélaton line. Coxa vara is seldom observed at as early an age as a congenital dislocation. There is also an absence of the freedom of motion seen in the latter affection. In coxa vara there is marked limitation of abduction and of inward rotation. In case of any doubt a skiagraph will clear up the diagnosis.

Paralytic Flail Joint (*Paralytic Dislocation*).—In this condition there is also displacement of the head, the trochanter lies above the Roser-Nélaton line, and there is lumbar lordosis. There is usually evidence in the thigh and leg of extensive paralysis, and atrophy or shortening (Fig. 517).

Dislocation Following Arthritis of the Hip.—The symptoms of the spontaneous forms of dislocations of the hip, following some of the infectious diseases, resemble those of the congenital form in almost every particular. There is, however, usually a history of the primary affection, and the fact that before the onset of the latter, the patient was able to walk perfectly. The motions of the hip are also not as free as in the congenital form.

Congenital Dislocations of Other Joints.—Congenital dislocation

of the knee is not frequent, only ninety-eight cases having been reported. It is regarded by some authors as a genu recurvatum or a hyperextension, rather than a displacement. It is, however, to be looked upon as a true dislocation, and is frequently double.[1] The leg is usually displaced forward, so that the condyles of the femur project in the popliteal space.

Congenital Dislocation of the Patella.—This is also infrequent. The displacement is usually outward, as in one of the varieties of traumatic dislocation. In this connection may be mentioned

FIG. 528.—X-RAY OF A CASE OF COXA VARA, TAKEN FROM THE PATIENT SHOWN IN FIGS. 529 AND 530.

Note the downward inclination of the neck of the femur on the side of the coxa vara (right), and the mushroom-like expansion of the head of the bone. On the left side the epiphyseal line between the head and the neck and between the greater trochanter and shaft respectively are well shown.

the rare occurrence of congenital absence of the patella, which can be recognized by the knee being broad and flat and very much impaired in function.

Congenital Dislocation of the Shoulder.—This is very rare. In the majority of cases reported as such it was due to relaxation of the joint (following the form of paralysis described on page 318) owing to tearing of the upper roots of the brachial plexus (Fig. 500). In others it is due to separation of the epiphysis.

[1] "Zeitschrift für orthopedische Chirurgie," vol. vii.

Coxa Vara.

The attention of the profession was first called to this interesting deformity by E. Müller[1] in 1888, and the name coxa vara given to it by Hofmeister in 1894. It may be defined as a bending downward (Fig. 528) of the neck of the femur sufficiently to cause symptoms. The neck may form a right, or even an acute, angle with the shaft.

Clinically it is seen most often in males during adolescence and less frequently in children.

It is best divided into the following forms:

1. Congenital coxa vara.
2. Rachitic coxa vara of childhood.
3. Coxa vara of adolescence.
4. Traumatic coxa vara.
5. Inflammatory and trophic coxa vara (following osteomyelitis, arthritis deformans, osteitis deformans, osteomalacia). The symptoms of all of these forms are the same, the division being according to the age at which it is first observed, and the etiology.

The form which requires especial mention in connection with its etiology is the traumatic. This term was first given to it by Sprengel in 1898.[2]

Fig. 529.—Typical Position in a Case of Coxa Vara Adolescentium.

This is the anterior view of the case shown in Figs. 528 and 530. A. A, Location of anterior superior spines of the ilium; B, B, the black point above these letters indicates the middle of the patellæ; C, C lower borders of internal malleoli. Note the shortening of the limb, the external rotation or eversion, and the prominence of the left trochanter.

It follows either a separation of the epiphysis or an actual fracture of the neck of the femur in children and young adults. In the case of epiphyseal separation, as well as of fracture of the neck, the head of the bone becomes flattened or mushroom-like and the neck bent downward so as to lie below the level of the trochanter. The injury may be so slight as to be overlooked, until the resulting deformity appears. Reference has been made to the symptoms of fracture of the femoral neck in children (page 575) which may result, according to Whitman,[3] in

[1] "Zeitschrift für orthopedische Chirurgie," vol. vii.
[2] "Archiv für klinische Chirurgie," vol. lvii.
[3] "Annals of Surgery," 1900.

coxa vara. The diagnosis of coxa vara of whatever origin depends upon the following clinical findings:

1. *The History.*—The early symptoms depend upon the cause. In those due to trauma there may have been a slight or severe injury, followed by vague pains in the hip, and later the appearance of the deformity. In others there is a history, in adolescence, of gradually increasing pains in the hip and discomfort on walking.

FIG. 530.—POSTERIOR VIEW OF A CASE OF COXA VARA ADOLESCENTIUM.

Same case as shown in Figs. 528 and 529. T, The arrow points to the prominent trochanter on the side upon which the coxa vara was situated; R, R. Roser-Nélaton line. Note how the trochanter lies above the Roser-Nélaton line on the side of the coxa vara. Also note the shortening and eversion of the limb.

2. *The Symptoms of the Deformity.*—(*a*) *Limitation of Motion.*—This is most marked in the direction of abduction and inward rotation, both of which are greatly restricted. The limitation of abduction is due to the pressure of the trochanter against the ilium, when the limb is abducted. The limitation of inward rotation is due to the fact that the neck of the femur is not only bent downward, but also backward in the majority of cases.

(*b*) *Attitude of the Limb.*—The limb is everted and adducted, except when the neck is bent forward. Under the latter conditions it is inverted.

(*c*) *Shortening.*—This is one of the most characteristic signs. There is genuine shortening as measured in the usual manner (Fig. 394). The trochanter lies above and a little behind the Roser-Nélaton line (Fig. 382), and is more prominent upon the side of the deformity. In children the shortening may be slight. There is also marked atrophy of the muscles of the thigh and gluteal region.

(*d*) *Gait and Pain.*—The patient stands upon the toes of the diseased side, the limb being adducted and rotated outward. He limps, and if the affection is bilateral there is a distinct waddling gait. There is also more or less pain in the [illegible], rarely in the knee, when walking. The Trendelenburg sign is well marked in unilateral cases.

3. *X-ray Examination.*—This shows the extent of the deformity. The bend is most frequently downward and backward, less often downward and forward, and least often simply downward. The mushroom-like flattening of the head is also well seen.

Differential Diagnosis.[1]—It is almost impossible to differentiate cases of traumatic coxa vara from those of true coxa vara of adolescence except from the history. If the trauma has been slight, even this may be misleading.

From Tuberculous Coxitis.—Coxa vara never gives rise to abscess formation, while this is of frequent occurrence in tuberculous coxitis. The onset of coxa vara is more abrupt and acute than it is in the majority of cases of tuberculosis of the hip-joint. It is a self-limited disease, and sooner or later a spontaneous cessation of the acute symptoms may be confidently expected, while the opposite clinical tendencies characterize tuberculous coxitis. This, like tuberculous processes in other parts and organs of the body, is generally attended by a slight rise in the evening temperature, while the temperature in coxa vara remains normal. In the great majority of cases, tuberculous coxitis is a disease of childhood, and begins, in the large proportion of instances as a primary osteal affection in the proximal end of the femur. Its onset is insidious. The pain is referred to the inflamed joint, and radiates along the course of the obturator nerve to the inner condyle of the femur. During the early stage of the disease, the thigh is slightly flexed, abducted, and rotated outward. Nocturnal muscular twitching is almost a constant symptom; this is something which is never found in coxa vara. In tuberculous coxitis, muscular rigidity fixes the joint at an early stage. All movements are productive of pain, and light blows against the condyles in-

FIG. 531.—DOUBLE GENU VALGUM (Fowler).

[1] The author has taken many of the differential diagnostic points from the article of Dr. Nid[illegible]

variably aggravate the pain. Tenderness, such a marked clinical feature in tuberculous and other inflammatory affections of the hip-joint, is never found in coxa vara. Shortening and outward rotation of the limb belong to the later stages of tuberculous coxitis, while in coxa vara they may even precede the painful or acute stage of the disease, and the shortening is always one of its early manifestations, usually combined with outward, and, in exceptional cases, with inward rotation of the limb. As a final diagnostic test in doubtful cases, the employment of the Röntgen ray will enable us to differentiate between the two affections (Fig. 528). In coxa vara, the downward bending of the femoral neck is almost characteristic, while in tuberculous coxitis the *x*-ray picture will either show the existence of a destructive process involving the proximal end of the femur, frequently complicated by coexisting or consecutive disease of the acetabulum, or it will show no change in the angle of the neck.

FIG. 532.- BOW-LEGS (Moore).

Bilateral coxa vara is of more frequent occurrence than bilateral tuberculosis, in the relative proportion with which these two diseases are encountered in practice. Muscular atrophy is more marked in tuberculous coxitis than in coxa vara.

Arthritis Deformans.—The differential diagnosis between coxa vara and arthritis deformans, called senile coxitis, where it affects the hip-joint, presents fewer difficulties. Coxitis senilis is a disease of advanced life.

Cases of senile coxitis are seldom met with in persons less than forty-five years of age.

In senile coxitis, the angle of the neck of the femur is not diminished. Arthritis deformans is not infrequently a polyarticular disease, while coxa vara is an affection which is only met with in the hip-joint. In senile coxitis, the head of the femur occasionally becomes elongated, but during the later stages the upper surface is [illegible]ved of its carti-

laginous covering, and the exposed underlying bone becomes hardened and is polished by the limited movements of the joint. There is no pain, no cracking, or roughness elicited by joint motion as in well-advanced cases of senile coxitis. The shortening of the limb in senile coxitis is not caused by bending downward of the neck of the femur, but by loss of tissue of the head of the femur and the upper segment of the acetabulum.

Genu Valgum (Knock-knee).

This may occur as a symptom of general rachitis in early life when the children first learn to walk (page 625). It also appears during adolescence (*i. e.*, between the twelfth and eighteenth years) as a static deformity. Genu valgum may also follow fractures of the femur and paralysis of the leg and thigh muscles.

Fig. 533.—Marked Shortening of Right Lower Extremity Following Anterior Poliomyelitis in Infancy.

Note the pes equinus paralyticus position of the foot.

The diagnosis in these varieties is not difficult. The chief features are:

1. An inward angular deformity (Fig. 531) at the knee-joint, which disappears when the leg is flexed upon the thigh.

2. When the leg is thus flexed the internal condyle is seen to be relatively prominent.

3. The gait is quite characteristic. It is a rolling one, the leg being thrown outward with each step forward.

The differentiation of either genu varum rachiticum or adolescentium from the paralytic or traumatic forms presents no difficulty. The presence of atrophied and paralyzed muscles will eliminate the paralytic form (Fig. 533), and the history of an injury will exclude the form following fractures of the femur or tibia or laceration of the internal lateral ligament of the knee.

Varum (Bow-legs).

In this deformity [illegible] and tibia form an outward angle (Fig. [illegible]). Like the corr[illegible] inward [illegible]ular deformity (genu valgum) it

is most frequently the result of rachitis, and is one of the earliest evidences of the latter. It is seen even in children who have never attempted to stand. In later life a similar deformity appears as a symptom of osteitis deformans (page 679).

FIG. 534.—TALIPES EQUINOVARUS (Moore).

The distinctive features of the rachitic genu varum are: (1) The gait is a waddling one, the feet and knees being wide apart and the toes usually inverted; (2) the deformity is most marked in the femur and tibia when one is in the standing position (Fig. 532). In the minority of cases the bowing is either angular and chiefly in the lower third of the tibia, or there is a forward curving of the tibia and sometimes of the femur also. To the latter class the term anterior bow-legs is applied.

FIG. 535.—TALIPES EQUINUS (Fowler).

DEFORMITIES CAUSED BY ANTERIOR POLIOMYELITIS.

These are generally of three varieties: (*a*) Those due to trophic changes, resulting in atrophy of the bone with marked shortening of the limb (Fig. 533). In these cases there is an increased liability to spontaneous fracture. (*b*) Those resulting from muscular paralysis. These either cause contractures or flail joints. (*c*) Dislocations, either complete or partial.

The first class are not difficult to recognize, the only other causes

of a shortened limb being a fracture through the epiphyseal cartilage or a resection of the ends of one of the long bones. In both, the history, the absence of motor paralysis, and the other signs of poliomyelitis will clear up the diagnosis. The deformities in the second class are the result of paralysis, which, as a rule, does not involve all of the muscles of the limb. In the thigh the muscles usually involved are those of the anterior and internal groups, resulting in a flexion of the hip and knee (Fig. 533). There is often a subluxation of the tibia backward and a marked genu valgum.

FIG. 536.—TALIPES CALCANEUS (Fowler).

In some cases there is hyperextension of the knee, combined with flat-foot.

The most common deformities of the foot in their order of frequency are (*a*) talipes equinovarus; (*b*) calcaneo-valgus; (*c*) pes calcaneous or pes cavus.

FIG. 537.—TYPICAL FLAT-FOOT (Gillette).

The third form of infantile paralysis deformities is not frequent. The most common is dislocation of the hip.

The diagnosis of all of these paralytic deformities depends upon the recognition of the primary disease, viz., poliomyelitis anterior. The onset is usually sudden, the paralysis is of the flaccid type, there is marked muscular and often bone atrophy, the paralysis usually affects only one limb and is not hemiplegic. The reaction of degeneration is also present.

TALIPES EQUINO-VARUS (CLUB-FOOT).

This is a deformity of the foot which is readily recognized. The majority of cases are of congenital origin. In a small number, however, the condition is an acquired one, usually secondary to an infantile paralysis. The foot is inverted and rotated upon its axis, so that the

outer border of the sole touches the ground (Fig. 534) and the toes point inward. The front part of the foot is at the same time depressed. The head of the astragalus and cuboid can be seen to project just beneath the skin, while the inner malleolus cannot be felt.

The congenital can be differentiated from the paralytic form by the presence of paralysis of the muscles on the anterior and external surface of the leg in the latter. The tendo Achillis in the acquired form is found to be very tense.

Talipes Equinus.

In this deformity the heel is drawn up, and the toes point downward. It may be of congenital or acquired origin. The former is not common, the usual combination being that of equino-varus or club-foot. An acquired talipes equinus may follow (*a*) infantile paralysis, (*b*) disease of the ankle-joint, (*c*) any form of spastic paralysis (hemiplegia, etc.), (*d*) fractures or diseases of the hip- or knee-joints. It varies in degree. In moderately severe cases the patient walks upon the ball of the foot, *i. e.*, upon the heads of the metatarsal bones. The toes are hyperextended (Fig. 535). Callosities and bursæ frequently form over the ends of the metatarsal bones. In milder cases, when the patient attempts to walk the weight is borne mainly upon the front half of the foot. In the most severe forms the weight is borne entirely on the dorsal surface of the metatarsals and toes, the sole of the foot being directed backward.

A B

Fig. 538.—A, Impression of Normal Foot; B, Impression of Flat-foot (Fowler).

Talipes Calcaneus.

This is comparatively rare as a congenital affection. It is usually an acquired deformity, and follows an infantile paralysis of the muscles of the calf of the leg.

The front part of the foot (Fig. 535) is drawn up by the muscles of the front of the leg. The patient walks upon the heel, and the gait is inelastic because the spring of the foot is absent. It is generally associated with a talipes valgus or talipes cavus.

FIG. 539.—HALLUX VALGUS (Fowler).

TALIPES CAVUS.

This is a condition in which the arch of the foot is increased so that the front of the foot approaches the heel. It is rarely congenital. In the majority of cases it is an acquired deformity, the result of an infantile paralysis.

TALIPES VALGUS.

This is one of the more common congenital deformities of the foot. The arch of the foot is entirely lost, the sole being everted so that it touches the ground at all points, and finally the front of the foot is turned out (abducted). Acquired talipes valgus differs from an acquired flat-foot by the absence of a distinct dropping of the arch of the foot. Its most common cause is an infantile spinal paralysis. It is much less painful than flat-foot.

FIG. 540.—APPEARANCE OF HAND IN A CASE OF WEBBED FINGERS.

The index, middle, and ring fingers are bound together so that they can only be distinguished at their distal ends.

FLAT-FOOT (PES PLANUS).

This affection is most common during adolescence, and is essentially a yielding or lowering of the arch of the foot. The instep is unable to support the weight of the body. It may develop either gradually or acutely. It may be due to a number of causes: (*a*) To occupations requiring prolonged standing, like that of waiters, etc.; (*b*) to rheumatism, especially gonorrheal; (*c*) after Pott's fracture (Fig. 405); (*d*) as a complication of rachitis; (*e*) weakness of the muscles

of the great toe and head of the first metatarsal bone; (*f*) improperly made shoes, with low insteps; (*g*) rapid growth or increase in weight; (*h*) infantile or spastic paralysis.

Clinically it can be readily recognized if close attention be paid to the normal condition, and also to the fact that not every painful affection of the foot is due to "rheumatism." There are two forms clinically: (1) Flexible flat-foot or weakened foot, where the flattened position is assumed as soon as weight is put upon the foot; (2) rigid or true flat-foot, in which the deformity is permanent, owing to alterations in

FIG. 541.—X-RAY OF ANTERO-POSTERIOR VIEW OF HAND SHOWING NEEDLE IN SITU.

FIG. 542.—X-RAY OF LATERAL VIEW OF HAND, SHOWING NEEDLE IN SITU.

the structures of the bones. The condition is more often bilateral than unilateral.

The diagnosis depends upon noting any lowering of the arch of the foot when the patient bears the weight upon it. An impression of the foot should be taken by allowing the patient either to step upon cardboard blackened with camphor smoke, or by covering the sole of the foot with oil and having him step upon a sheet of paper, placing the extra weight upon the foot.

A variable degree of pain is present in the neighborhood of the scaphoid, and often it is also referred to the leg, knee, back, or hip.

In the milder cases it is only noticed when the foot is stepped upon. In the more severe, the pain is constant, and independent of bearing the weight upon the feet. There is also some tenderness over the most painful points, viz., over the scaphoid, outer border of the foot, center of the heel, front of the foot, and behind the inner malleolus. At times the pain and tenderness seem so distinctly localized, that an inflammatory focus is thought of.

FIG. 543.—X-RAY OF GUNSHOT WOUND OF HAND.
Showing bullet embedded on metacarpal bone of thumb.

Inflammation of the tendon-sheaths of the peroneal and tibial tendons, in the shape of elongated soft swellings along the front and sides of the ankle, are often the symptom for which the physician is consulted. In very acute cases the foot is held abducted through contraction of the peroneal muscles. The foot is often swollen, and becomes so rigid that the front of the foot cannot be adducted actively or passively as much as it can normally (Lovett).

There is also limitation of motion in the ankle-joints. When the patient walks, the feet are everted, and the weight is borne upon the inner side of the foot. There is a lack of elasticity in the gait.

In children there is but little pain on walking. The physician is often consulted because the child tires easily, or complains of pain in the legs, back, or hips. Rigidity is rarely present. The child cannot balance itself well, and falls frequently. There is usually a greater degree of flattening than in adults.

Metatarsalgia (Morton's Disease).

This condition is characterized by frequently recurring attacks of severe pain, which usually appear between the third and fourth or fourth and fifth toes while the patient is walking. The anterior arch of the foot, formed by the heads of the metatarsals, is often relaxed or flattened, so that the heads of the second, third, and fourth metatarsal bones are on a lower level than normal. The arch of the foot is often flattened. The toes are often rigid, and dorsal flexion of the foot may be limited.

Hallux Valgus.

This is a deformity of the great toe, in which the phalanges are pushed outward and form an angle with the head of the metatarsal bone, which becomes enlarged. The bursa lying over the latter may become inflamed from time to time, and be present as a tender, soft swelling (bunion), which becomes acutely inflamed at intervals.

Congenital Deformities of the Hands.

Club-hand is usually associated with other deformities. The hand is flexed and drawn over to the radial side.

Webbed fingers (syndactylism) involves two or more fingers. The union extends a variable distance to the tips (Fig. 540). It is often associated with a lack of development of the bones of one or more fingers.

Supernumerary digits (polydactylism) are also congenital. They are generally symmetrical and involve hands and feet (Fig. 65). Usually there is but a single digit in excess, on the side of the little finger or little toe. The development may be complete or more or less imperfect.

Carpus Varus and Carpus Valgus (Madelung's Deformity).

Madelung in 1878 called attention to a deformity of the wrist, which consisted of an apparent forward subluxation of the wrist produced by the

inclination of the articular surface of the radius toward the flexor aspect of the wrist. This was the result of a forward bowing of the axis of the radius at the lower epiphysis. Madelung believed that the deformity was due to a disturbance of growth in the joints. It develops spontaneously, never before thirteen, and rarely before twenty-three, with pain and limitation in the extension of the hand. Flexion may be increased while the restriction of adduction and abduction varies. The affection is usually unilateral and twice as frequent in women as in men. The patients generally belong to the working classes and the deformity usually reaches its height in one to two years. The disease requires as a predisposing factor a primary weakness of the bones or a disturbance of nutrition such as that due to disease. The earliest symptom is more or less severe pain in the wrist-joint, which is increased by motion. When the deformity has become stationary, there is restriction of extension in the forward type and of flexion in the backward type. Externally the deformity is quite characteristic and the radiograms will confirm the diagnosis. The forward type is more common than the backward. The anteroposterior bowing of the radius, usually of the shaft proper, occasionally of the epiphysis, produces a deviation of the articular surface and an apparent subluxation of the wrist. The deformity[1] is usually bilateral.

Foreign Bodies in the Hands or Feet (Figs. 541, 542, 543).

Various foreign bodies may penetrate the integument and remain embedded in the subcutaneous or deeper tissues. The most frequent locations of these are the hands and feet, and the usual substances, needles, portions of a bullet, bits of glass, etc. The most reliable method of locating these is by the use of the *x*-ray. One should never depend upon a fluoroscopic view of their location, care being taken to take skiagraphs in two directions. This method is to be especially recommended for needles.

[1] An excellent description by DeWitt Stetten, of this interesting deformity has been recently published in the January, 1909, number of "Surgery, Gynecology, and Obstetrics."

CHAPTER VI.

DISEASES AND INJURIES OF THE SPINE.

SPINA BIFIDA.

This congenital deformity of the spine occurs most frequently on the posterior aspect, less often on the ventral or anterior surface. Various combinations occur as the result of a non-closure of the neural arches. These are:

Rachioschisis.—This is due to a complete or partial absence of union of the medullary canal. This is the most severe form. There is a defect of normal skin in which an open depression exists, at the base of which a soft red band of vascular tissue is found, which represents the cord. It rests upon a thin reddish membrane, which represents the pia mater, which is continuous on both sides with the skin. The dura and arachnoid lie beneath it, and pass over into the subcutaneous tissue. The arches are present as short stumps, and the bodies are greatly deformed.

Myelocele or Myelomeningocele.—The conditions of the bones are the same as in the first form (rachioschisis), but, owing to the accumulation of fluid between the membranes on the ventral side, the cord and its coverings on the dorsal aspect are pushed out and form a visible thin-walled sac. The cord lies upon its inner side and is closely adherent to it. As in the first form there is a defect of skin, thus favoring infection.

Myelocystocele.—This is a smaller or larger sac whose outer covering is thin, but otherwise unchanged. The innermost layer is composed of greatly thinned cord. Between it and the skin are found two thin vascular layers, representing the pia and arachnoid. This form of spina bifida is the result of the accumulation of fluid in the central canal, and the dilated cord is covered by piaarachnoid and skin. The dura does not take any part in the coverings of this or the two preceding forms.

Meningocele.—In this form a cyst with a narrow pedicle is found. The sac is either composed of piaarachnoid, with fluid in the subarachnoid space, or only of dura, with fluid in the subdural space. The cord seldom participates in the formation of the sac. When it does the condition is known as a myelocele.

The diagnosis of a spina bifida itself is, as a rule, not difficult. The majority occur on the posterior aspect of the spine in the lumbo-sacral region (Fig. 544). Rachioschisis and myelomeningocele can be recognized by the defect in the skin. In both, deformities as well as paralyses of the extremities are frequently found, with or without involvement of the sphincters. The third and fourth forms, viz., myelocystocele and myelomeningocele, are covered by normal but thinner skin. The first named is often associated with other deformities, such as

FIG. 544.—SIDE AND FRONT VIEWS OF A CASE OF EXTENSIVE SPINA BIFIDA.

hydrocephalus, club-foot, etc. These two forms can only be distinguished when the sac is opened. In a meningocele one finds a smooth serous inner wall, while in a myelocystocele there is a reddish-brown vascular tissue which leads into the open cord. Meningoceles are rarely accompanied by symptoms of paralysis. When pressure on the tumor causes the fontanelles to bulge it is more likely to be a myelocystocele.

Myelomeningoceles are usually found in the sacrum, while myelocystoceles may occur anywhere.

INJURIES OF THE SPINE.

In the examination of a patient suffering from an injury to the vertebral column either recent or of long standing, the following routine will be found useful:

1. How was the injury received?
2. What is its probable nature?
3. Does evidence of compression or destruction of the cord or its nerves exist?
4. At what level did such injury occur?
5. What are the objective evidences of such injury, exclusive of that of the cord?

General Consideration.—Before discussing spinal injuries in detail a brief résumé of our present knowledge of their pathology and the chief points in spinal localization will be taken up.

Pathology of Injuries of the Spine.—Injuries of the vertebræ usually occur in adult life and in an indirect manner. The direct modes of injury affect the arch, while the indirect involve the body of the vertebra. Most frequently the indirect are the result of a sudden bending forward (flexion) of the spine. Only in a small proportion of cases do hyperextension or lateral or rotary forces play a rôle.

Pure Fractures are Quite Rare.—In the majority of cases the injury is a combination of a fracture and a dislocation. Such fracture dislocations are most apt to occur between the tenth dorsal and second lumbar vertebræ. True dislocation without fracture is most apt to occur in the cervical region.

The part most frequently fractured is the body of the vertebræ.

The general statements on page 510 in regard to fractures of the bones of the extremities hold true for those of the vertebræ. Compression fractures are more common, however, than in the case of any other bones except those of the tarsus (Fig. 318). The compression may be so extreme that the upper and lower intervertebral discs may be brought into contact with each other, the substance of the bone being partly compressed and partly displaced upon the sides or behind into the spinal canal (Fig. 545).

With this may be associated fractures of the arches, spinous and transverse processes, or extensive tears of the ligaments.

By *dislocation of a vertebra* is meant an injury in which the adjoining articular processes on one or both sides have been partly or completely separated from each other. If a fracture of the body or its arch has occurred at the same time in a true dislocation, such a

fracture can be deemed unessential to the production of the dislocation.

The normal range of motion between adjoining vertebræ is in two axes, one vertical in the median plane, and the other horizontal, passing through the posterior part of the disc. There are two modes or varieties of dislocation, viz., (*a*) by abduction, which includes complete or incomplete unilateral dislocations forward or backward, and (*b*) by flexion, which includes bilateral dislocations forward or backward.

The spinal cord terminates at the lower border of the body of the first lumbar vertebra. It is made up of a number of segments, similar and partly independent, which correspond to the vertebral bodies and each pair of spinal nerves. Every segment possesses motor, sensory, and reflex functions besides vasomotor, visceral, and trophic activities. The spinal cord may be injured directly (*a*) by the displacement of a fragment; (*b*) by the pressure of a dislocated vertebra; (*c*) by a blood-clot; (*d*) by an inflammatory exudate; (*e*) by elongation; (*f*) by being penetrated by a fragment (rare); (*g*) by being penetrated by a cutting instrument (stab wound) or a bullet. In one case observed by the writer a piece of tin was thrown horizontally in such a manner as to enter between the atlas and skull and sever the cord.

FIG. 545.—FRACTURE-DISLOCATION OF SPINE, SHOWING CRUSHING OF THE CORD (Guy's Hospital Museum).

In fractures, the cord is usually caught between the anterior portion of one fragment and the posterior portion of another (Fig. 545).

The dura is seldom torn, the cord being pulpified at the moment of the injury. Hemorrhage may occur either around the cord (extradural), or within its substance (hematomyelia).

The blood in the former case spreads up and down in the canal, and thus compresses the cord.

In hematomyelia the hemorrhage may take place into the gray

matter alone and be limited to a few segments, or, if the lesion is more severe, the hemorrhage extends into the white columns. If the patient survive, the absorption of the clot leaves cavities which fill with scar tissue. The elements of the gray matter are thus permanently destroyed. Apparently most of the cases of injury to the neck which recover after having presented symptoms of severe injury to the cord are cases of hematomyelia.

Spinal Localization.

A knowledge of the functions of the various spinal cord segments is absolutely essential to the diagnosis of surgical lesions of the cord. Such cord lesions may follow (*a*) the pressure of a fragment in fractures of the vertebra; (*b*) the pressure of a dislocated vertebra; (*c*) hemorrhage into or around the cord; (*d*) a stab or gunshot wound; (*e*) pressure of a tumor or inflammatory exudate.

Cord lesions cause: (*a*) irritation; (*b*) partial destruction, or (*c*) complete destruction.

(*a*) *Irritative lesions* cause hyperesthesia, pain, spasms, rigidity, and increased reflexes.

(*b*) *Partial Destruction of a Segment.*—This is seldom strictly unilateral. If only one lateral half of the transverse cord section is involved, as occasionally occurs after stab wounds, the complex symptom known as *Brown-Séquard paralysis* develops. There is complete loss of power on the same side as the lesion in all parts below that point. There is also a slight loss of power below the lesion upon the opposite side. Anesthesia is complete on the side opposite the lesion, below its level.

There is a band of cutaneous anesthesia upon the same side as the lesion which marks its exact level. It varies vertically according to the extent of cord destroyed. There is a band of hyperesthesia above and below the band of anesthesia on the paralyzed side. On the opposite or anesthetic side, there is also a band of hyperesthesia a little below the level of the hyperesthetic band of the paralyzed side. The reflexes are increased below the lesion on the paralyzed side, but are abolished at the level and throughout the vertical extent of the lesion.

The muscular paralysis in these partial cross-lesions is usually of a spastic character, because the reflexes are preserved and increased as just stated.

In late cases of partial cross-lesions, the rigidity and spastic features

are well developed (Church). The lower limbs are either held rigidly extended or less frequently, flexed. Contractures finally develop (Fig. 546).

(*c*) *In total destruction of the cord* the symptoms are in general: (1) Paralysis of the muscles supplied by the segment involved and of all muscles represented in the cord below the lesion. This results in a paraplegia. (2) Anesthesia in the area of skin supplied by the segment and in all parts below. This is really the best guide to the level of the lesion. (3) A zone of hyperesthesia at the upper border of the area of anesthesia.

FIG. 546.—MARKED PARALYTIC CONTRACTURES OF THE LOWER EXTREMITY FOLLOWING COMPRESSION MYELITIS, DUE TO FRACTURE OF THE SPINE.

In the trunk total transverse lesions of the cord produce an anesthesia whose upper limit is horizontal, while lesions of the nerve-roots cause anesthesia or hyperalgesia which follows the direction of the intercostal nerves and spaces. (*d*) The reflexes furnish very valuable evidence not only as to the upper level of the cord lesion, but sometimes as to its vertical extent. *Complete destruction of the cord extinguishes all reflexes below the level involved, while partial division causes an enfeeblement of the same reflexes*, which later on is succeeded by an exaggeration of the same.

The absence of one or more of these increased reflexes in such a case points to the level of the lesion. Again, the upper level of abolished reflexes usually coincides with that of anesthesia, and either one enables us to locate the lesion.

(*e*) *Trophic Disturbances.*—The extent of muscular atrophy depends upon the vertical dimensions of a lesion. The muscles innervated from the cord above and below the destructive process are spared, and regain their nutrition and electrical reaction. The normal galvanic

response gradually disappears in the atrophied muscles and is replaced by the reaction of degeneration. In acute destructive lesions and cord hemorrhage, acute bedsores may form in a few hours over the sacrum, heels, malleoli, and trochanters (Fig. 546).

(*f*) *Vasomotor Changes.*—The paralyzed limbs are warmer than normal, and there is distention of the subcutaneous veins. Priapism is a very common sign of such vasomotor paralysis in lesions of the cervical segments. In addition the latter often cause flushing and perspiration on the side of the neck and face and may reduce the heart-beats to forty or less per minute. Dorsal lesions are sometimes attended by a persistently rapid pulse.

(*g*) *Visceral Symptoms.*—There is usually disturbance of the anal and vesical sphincters. When their reflex centers in the lumbar cord are destroyed the sphincters are completely relaxed, and incontinence results. If the lesion is above their spinal center only voluntary control is lost. This results in retention of urine and feces. The distention of the bladder may become so extreme that overflow occurs, resulting in the constant dribbling of urine. This latter condition is called incontinence of retention.

Cystitis and pyelonephritis almost invariably follow the continued and unavoidable use of the catheter in these cases, despite every precaution to prevent infection.

The retention of feces present in the early stages often gives way to incontinence.

Intestinal obstruction, of the variety known as adynamic ileus, may develop immediately after an injury of the spinal cord. It may be temporary or permanent, the latter invariably resulting fatally.

This paralysis of the intestinal musculature is the result of the involvement of the splanchnic nerves. The clinical picture in such cases resembles that described under intestinal obstruction (page 320).

Acute gastric dilatation may also develop as a complication of spinal cord injuries.

A study of the accompanying table of symptoms[1] (pages 763 to 768) will be found extremely useful in the diagnosis of the level of a cord lesion. The table shows the clinical signs in cases of disabling, but not absolutely destructive, cord lesions. If the entire cross-section is absolutely destroyed the symptoms are the same, but there is complete absence of muscle reflexes below the lesion.

[1] Wichmann: "The Relations of the Spinal Nerves and Segments," Berlin, 1900.

TABLE OF SYMPTOMS IN CROSS-LESIONS OF THE CORD.—(*Church and Peterson.*)

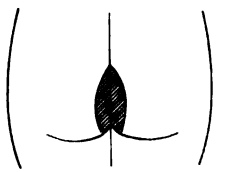
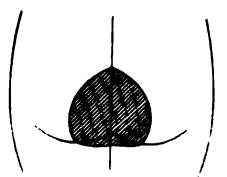
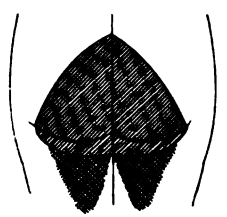
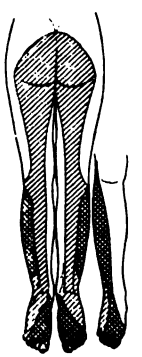
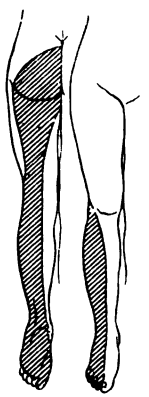
Lesion. Segment.	Motor Conditions.			Reflex Conditions.		Sensory Conditions.	
	Paralysis.	Paresis.	Actions Lost or Impaired.	Absent.	Increased in Partial Lesions.	Anesthesia Marked by Diagonal Lines.	Hypesthesia Marked by Crossed Lines.
V. Sacral.	None.	Coccygeus.	Elevation of coccyx.	None.	None.		
IV. Sacral.	Coccygeus	Levator ani. Sphincter ani. Detrusor urinæ. Transversus perinei. Erector penis. Compressor urethræ.	Elevation of coccyx. Elevation of anus. Sphincter ani. Ejection of urine. Vaginal constriction.	Erection of penis diminished.	None.		
III. Sacral.	Sphincter ani. Levator ani. Detrusor urinæ. Transversus perinei. Erector penis. Compressor urethræ.	Rectum.	Defecation disturbed. Retention of urine, later followed by dribbling. Ejaculation lost. Erection possible, but paretic. [Testicle sensitive to pressure.]	Ejaculation lost. Erection diminished. Tendo Achillis.	None.	Rider's breeches form.  Perineum. Anus. Scrotum (posterior inferior part or labia). Penis. Thigh. uppermost posterior part hypesthetic.	

TABLE OF SYMPTOMS IN CROSS-LESIONS OF THE CORD.—(*Continued.*)

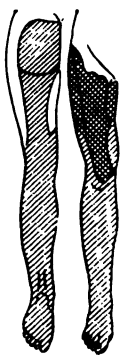
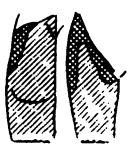
Lesion. Segment.	Motor Conditions. Paralysis.	Paresis.	Actions Lost or Impaired.	Reflex Conditions. Absent.	Increased in Partial Lesions.	Sensory Conditions. Anesthesia Marked by Diagonal Lines.	Hypesthesia Marked by Crossed Lines.
II. Sacral.	Sphincter ani. Levator ani. Detrusor urinæ and other muscles as in III. Sacral.	Pyriformis. Obturator internus. Gemellus superior. Gluteus maximus. Biceps femoris. Gastrocnemius. Soleus. Tibialis posticus. All the small muscles of foot.	Outward rotation thigh. Retraction thigh. Flexion of knee. Plantar flexion of foot. Standing on the toes. Raising inner margin of foot. Defecation, Retention } as in III. Sacral.	Ejaculation. Erection. Plantar weakened.	None.	Anesthesia of genitalia, except base of penis and scrotum; hypesthetic.	
I. Sacral.	Muscles of anus. Muscles of bladder. Muscles of genitals. Pyriformis. **Adductor hallucis.** Flexor hallucis brevis. I-IV, Dorsal interossei. I-III, Plantar interossei. III-IV, Lumbricales. Abductor minimi digiti. Opponens minimi digiti.	Gluteus maximus. Obturator internus. Gemellus superior. Gluteus medius. Gluteus minimus. Biceps. Semimembranosus. Semitendinosus. Popliteus. Gastrocnemius. Soleus. Tibialis posticus. Peroneus longus. Peroneus brevis. Flexors of toes. Extensors of toes.	Retention of feces. Retention of urine, or dribbling Erection and ejaculation impossible. Outward rotation of thigh impaired. Internal rotation impaired. Flexion of knee difficult. Plantar flexion of foot. Raising inner margin of foot. Raising outer margin, and dorsal flexion of foot. Flexion and extension of toes, adduction of great toe, abduction of little toe, etc.	Plantar weakened. Achilles-tendon reflex. Ejaculation. Erection. Micturition. Defecation. Gluteal.	None.		

V. Lumbar.	Muscles of anus and rectum.		Defecation.	Ejaculation.	Plantar.
	Muscles of bladder.		Micturition delayed, dribbling.	Erection.	Tendo Achillis.
	Muscles of genitals.		Erection, ejaculation impossible.	Micturition.	
	Pyriformis.	Gemellus superior.	Outward rotation of thigh very difficult.	Defecation.	
	Obturator internus.	Gemellus inferior.		Gluteal.	
		Gluteus medius.	Inward rotation impaired.		
		Gluteus minimus.			
	Biceps femoris.	Semimembranosus.	Flexion of knee difficult.		
		Semitendinosus.			
		Gluteus maximus.	Retraction of thigh very difficult.		
		Tensor fasciæ femoris			
		Gastrocnemius.	Flexion of foot barely possible.		
		Soleus.			
	Flexors of toes.		Flexion of toes impossible.		
		Extensors of toes.	Extension of toes weak, except great toe, which may be dorsally flexed.		
		Tibialis anticus.	Raising inner margin of foot difficult.		
	Peroneus longus.		Raising outer margin of foot impossible.		
	Peroneus brevis.				

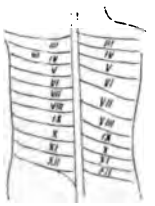


IV. Lumbar.	Muscles of rectum and anus.		Defecation.	Patellar may be wanting.	Plantar.
	Muscles of bladder.		Micturition delayed, dribbling.		
	Muscles of genitals.		Erection, ejaculation impossible.		
	Obturator internus.	Obturator externus.	Outward rotation of thigh weak.		
	Pyriformis.				
	Gemelli.				
	Gluteus medius.		Inward rotation impossible.		
	Gluteus minimus.				
	Gluteus maximus.		Retraction of thigh impossible.		
	Biceps femoris.				
	Semimembranosus.		Flexion of knee lost.		
	Semitendinosus.				
	Popliteus.				
	Gastrocnemius.		Plantar flexion of foot lost.		
	Soleus.				
	Flexors of toes.		Flexion and extension of toes lost.		
	Extensors of toes.				
	Peroneus brevis.		Raising outer margin of foot.		
	Peroneus longus.		Raising inner margin.		
	Tibialis anticus.				
		Rectus femoris.	Extension of thigh weak.		
		Vastus externus.			
		Vastus internus.			
		Adductor magnus.	Adduction difficult.		
		Adductor brevis.			
		Adductor minimus.			
		Gracilis.			

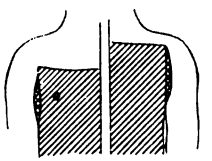
TABLE OF SYMPTOMS IN CROSS-LESIONS OF THE CORD.—(*Continued.*)

Lesion. Segment.	Motor Conditions. Paralysis.	Paresis.	Actions Lost or Impaired.	Reflex Conditions. Absent.	Increased in Partial Lesions.	Sensory Conditions. Anesthesia Marked by Diagonal Lines. Hypesthesia Marked by Crossed Lines.
III. Lumbar.	Muscles of anus, bladder, and genitals. Outward rotators thigh. Inward rotators thigh. Retractor (flexor) thigh. Flexors of knee. Plantar flexors of foot. Flexors of toes. Extensors of toes. Extensors of foot. Vastus externus.	Vastus internus. Rectus femoris. Crureus. Adductors of thigh. Flexors of thigh at the hips.	Extension of leg almost impossible. Psoas and iliacus can lift the leg somewhat, however.	Patellar. Cremasteric.	Ankle-clonus may exist.	
II. Lumbar.	Paralysis of all muscles of lower extremity except psoas.	Psoas.	All motions lost. [Testicle not sensitive to pressure.]	Patellar. Achilles. Cremasteric.	Achilles may be increased. Plantar.	 Total anesthesia of lower extremity except territory of the ilio-inguinal and external cutaneous, which is hypesthetic.
I. Lumbar.	**Total paralysis of whole lower extremity, psoas included.**			Cremasteric. Achilles.	Patellar none or increased. Plantar. Ankle clonus.	

XII–III. Dorsal.	Paralysis of lower extremity, and gluteal region. Paralysis of abdominal and dorsal regions gradually added as the site of the lesion ascends.		Paralysis of muscles of respiration causes diaphragmatic breathing and dyspnea.	In complete lesions epigastric reflex and abdominal reflex may be abolished. All below lost in complete division of cord.	Increased in incomplete lesions. Patellar. Cremasteric. Achilles. Plantar.
II. Dorsal.	As in III. Dorsal.			All below lost in complete division of cord.	All subjacent reflexes.
I. Dorsal	All muscles of trunk and lower extremities.	Flexors of fingers. Muscles of the little finger. III and IV Interossei. Lumbricales. Pronator quadratus. Lower part pectoralis major. Lower part pectoralis minor.	Weakness in flexion of fingers. Pronation disturbed.	Oculopupillary symptoms. All below lost in complete division of cord.	All below increased.



Anesthetic area begins, as a rule, two segments below site of lesion, these two intervening segments being hypesthetic.



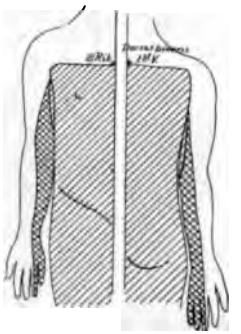
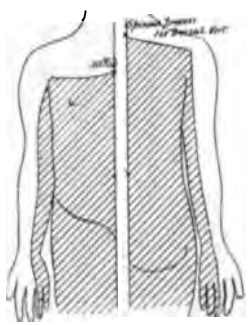
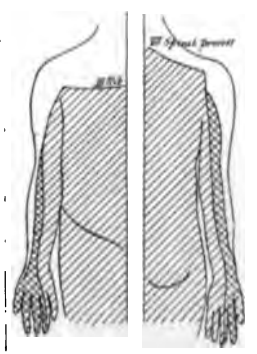
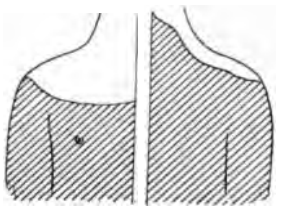


TABLE OF SYMPTOMS IN CROSS-LESIONS OF THE CORD.—(*Continued.*)

Lesion. Segment.	Motor Conditions. Paralysis.	Paresis.	Actions Lost or Impaired.	Reflex Conditions. Absent.	Increased in Partial Lesions.	Sensory Conditions. Anesthesia Marked by Diagonal Lines.	Hypesthesia Marked by Crossed Lines.
	Paralysis muscles of trunk and lower extremities. Abductor of little finger. Adductor of thumb. Flexors of the little finger. Opponens minimi digiti. III and IV Interossei. Lumbricales.	Flexors of the little finger. Opponens minimi digiti. Flexor sublimis digitorum. Flexor profundus digitorum. Flexor carpi ulnaris.		Oculopupillary symptoms. All below lost in complete division of cord.	All below increased.		
VIII. Cervical.		Extensors of the thumb and fingers. Extensor carpi ulnaris.	Hand weak.				
		Triceps (slight). Latissimus dorsi (lowest part). Pectoralis major. Pectoralis minor. Scalenus medialis. Scalenus posterior.	Extension of arm. Int. rotation and retraction of arm. Adduction of arm.				
VII. Cervical.	Lower extremities and trunk. Flexor profundus digitorum (ulnar side). Flexor carpi ulnaris. Small hand-muscles. Pronator quadratus.	Extensors, Flexors, Abductors of thumb. Extensor indicis. Extensors of the fingers (movements barely possible). Supinator longus. Biceps (very slightly paretic). Triceps. Pectoralis major. Serratus magnus (slight). Latissimus dorsi. Teres major.	Hand very weak. ("Winged" scapulæ.) Retraction and inward rotation of the arm.	Arm reflexes. Forearm reflexes. Palmar reflex. All below lost in complete cord division.	All below increased.		

VI. Cervical.	Muscles of lower extremity and trunk. Muscles of fingers (including thumb) and hand. Triceps. Pectoralis major. Latissimus dorsi. Teres major. Infraspinatus. Serratus magnus.	Coracobrachialis. Biceps. Brachialis anticus. Supinator brevis. Deltoid. Scaleni. Splenii. Deep head and neck muscles.	Movements of fingers and thumb impossible. Extension of forearm. Flexion of forearm weak. Supination very weak. Adduction of arm and inward rotation. Adduction, retraction, and external rotation. "Winged" scapula. Raising of arm. Rotation of head. Fatal in a few days or weeks.	Arm-reflexes Extensor forearm reflexes. All below lost in complete cord division.	All below increased.
V. Cervical.	Muscles of lower extremity and trunk. All the muscles of the arm, forearm, hand, and fingers; even the deltoid, coracobrachialis, and brachialis anticus. Deep cervical muscles. Intercostals.	Levator anguli scapulæ. Scaleni. Diaphragm (because of filaments from V. cervical segment of the phrenic nerve), or spread of injury from 5th to 4th cervical segment. Trapezius and sternocleidomastoid are intact.	Shoulders raised with difficulty. Rotation and flexion of head. Dyspnea. Fatal in a few hours or days.	Scapular. Tendon reflexes of paralyzed muscles. All below lost in complete cord division.	All below increased.
IV–I. Cervical.	Total cross-lesions from the fourth cervical segment upward are rapidly fatal, because of complete paralysis of the diaphragm and intercostals.				



Lesions of the Cauda Equina.—The cauda equina is made up of the descending roots of lumbar, sacral, and coccygeal nerves. It is about ten inches in length. It is affected by the same lesions as the spinal cord itself. The sensory, motor, trophic, and reflex symptoms are the same as follow division of the individual nerve-trunks. In partial lesions, sensation may be but slightly disturbed when motion is quite lost. Increased reflexes are not encountered. The lowest portion of the cauda is usually involved, and the lesions cease at some definite upper level. Most cord lesions, on the other hand, are limited in vertical extent, and the reflex and trophic disorders are confined to the corresponding body segments.

In the examination of an individual, for the purpose of making a diagnosis of an injury of the spine and spinal cord, the various conditions which require consideration are: (1) Fractures; (2) dislocations; (3) hematorachis and hematomyelia; (4) concussion of the spine; (5) traumatic spondylitis.

Fractures of the Spine.

A true fracture of the vertebral column without accompanying dislocation is so infrequent that the term "fracture-dislocation" would be more appropriate. Their diagnosis can be best considered in connection with the individual regions.

Of the Upper Two Cervical Vertebræ (Atlas and Axis).—Three classes of cases occur clinically, viz.: (*a*) Those in which death is immediate, and no diagnosis can be made as to whether fracture or dislocation existed. (*b*) Those in which death occurs, weeks to months after the injury, as the result either of a secondary myelitis or after a sudden movement of the patient. In the absence of paralysis a diagnosis cannot be made in these cases. (*c*) Those in which no symptoms exist, and the nature of the injury often remains unrecognized. These last-named cases are usually diagnosed as sprains. They complain of pain in the neck and it is held rigid.

It was formerly thought that practically all of the cases of fracture or dislocation of the atlas or axis belonged to the first group, *i. e.*, where death was immediate. According to Gurlt, these constitute the minority.

In the second group, where the patient survives and the symptoms of secondary myelitis appear, the diagnosis can be made from the latter, and is occasionally confirmed by the palpation through the mouth of the displaced vertebra at the level of the bony septum. In some cases the paralysis involves all of the parts below the fracture.

In others there is only partial paralysis, and, in one case, only a slight diminution of sensibility in the left arm.

From the Third Cervical to the Second Dorsal Vertebra Inclusive.—In this region one must distinguish fractures of the body from those of the arch. If the latter occur, there is crepitus or irregularity of the spinous processes. In respect to the latter, it must not be forgotten that the third and fourth cervical spines normally lie quite deeply.

In fractures of the body an abnormal prominence can often be felt through the pharynx.

The position and mobility of the head vary greatly. It is held rigid in the majority of cases, the shoulders being drawn up and the neck shortened. In some cases the head can be moved freely to either side, but not forward or backward.

As a rule symptoms of pressure upon the spinal cord appear early. They may be due to (*a*) a hemorrhage into or around the cord, or (*b*) compression by a fragment or displaced vertebra.

If no spinal symptoms occur a differential diagnosis can only be made by an *x*-ray examination, and the fact that the symptoms persist for a longer period.

If the third to fifth cervical vertebræ are broken, death either occurs from paralysis of the phrenic nerve or the diaphragm acts only two or three times a minute, accompanied by a very slow pulse.

The extent of the peripheral paralysis accompanying compression of the cord in this region varies. Paralysis of the arms is not as constant as one would expect. Often the paralysis only extends to the level of the umbilicus or breast. The paralysis of the arms is quite often absent. In some cases the paralysis of the arms may appear upon the day after the accident, or even later. It may involve only one arm or a single group of muscles.

In some cases there is great dyspnea, especially during expiration, as a result of paralysis of the intercostal and abdominal muscles. In other cases there is marked difficulty in speech and swallowing.

There may be paralysis of sensation or of motion alone. Hyperesthesia of part or all of the arm is at times observed, as well as tonic and clonic spasms. Other symptoms of injury to this region are vasomotor changes in the face and neck, priapism, and a high temperature. In rare instances the vertebral artery has been torn, a large clot forming between the muscles of the neck. In some cases the *x*-ray has proved to be of great value. The question as to whether the cord symptoms are due to compression of a fragment [illegible] dis-

located vertebra, or whether they are due to hematomyelia, will be considered later (page 775).

Fractures from the Third to the Twelfth Dorsal Vertebræ.—The diagnosis of fractures in this region is not very difficult. The arch is rarely involved. Usually the bodies (Fig. 545) of one or more vertebræ are involved with direct compression of the cord. In the majority of cases the condition can be recognized (*a*) by the symptoms of spinal cord compression plus (*b*) the local evidences of injury. In some cases the compression symptoms may exist without a discernible deformity, and again there are instances where the gibbus or angular deformity is quite marked and yet no paralysis, etc., exists. The spinal cord symptoms may, as in the case of injuries higher up, be due to the compression of a blood-clot (page 775).

As a rule, the arms escape paralysis. In the most typical cases there are (*a*) paralysis of motion in the lower extremities (paraplegia); (*b*) paralysis of the bladder and rectum, resulting in retention of urine and feces; (*c*) anesthesia to the level of the injured vertebræ (pages 767 and 768); (*d*) paralysis of the abdominal and intestinal muscles. As is the case in all spinal injuries, these are subject to great variation, The motor paralysis may be irregular or even absent. The paralysis of the abdominal muscles causes the breathing to be shallow and diaphragmatic.

The tympanites resulting from the paralysis of the abdominal muscles and that of the intestinal musculature may become so extreme as to cause death from a paralytic or adynamic ileus (page 321).

Locally the diagnosis of fractures in this region is greatly aided if an angular deformity or a distinct hiatus be found. The spines may be abnormally separated or prominent, or may crepitate. This can be best elicited by passing the finger along the spinous processes. The majority of these patients die from an ascending pyelonephritis in spite of the utmost precautions taken to prevent infection during catheterization. Those who survive often show marked contractures.

Fractures of the Lumbar Vertebræ.—Fractures in this region decrease in frequency from above downward, those of the last three vertebræ being very rare. Only the first lumbar is frequently broken. The symptoms are chiefly those of pressure upon the cauda equina (page 770), since the spinal cord ends opposite the lower border of the first lumbar vertebra. Paralysis is often absent, and if it is present it resembles that of injuries of the individual peripheral nerves. The paralysis of the extremities is often unequal or irregular, being con-

fined to flexors of the thigh and leg. Anesthesia is present in a similar irregular manner. There are often sharp pains, referred along the course of the peripheral nerves, and paresthesia. Reflexes are either absent or are only feebly present. Muscular atrophy appears very early. Vesical and rectal paralysis is frequently present.

Dislocations of the Vertebrae.

A dislocation of a vertebra is defined as an injury in which the articular processes of one or both sides have completely separated from each other, accompanied by more or less displacement of the body. The term diastasis is applied by Blasius to those dislocations in which the ligaments and intervertebral discs are so torn, that the vertebræ are separated from each other in front or behind, in a longitudinal direction. They are not displaced on each other horizontally, so as to separate the articular surfaces from each other completely, as in the case of a true dislocation.

True dislocations are most frequent in the cervical region, quite rare in the dorsal, and rarest of all in the lumbar region. We usually speak of the upper of the two vertebræ as the dislocated one. A diastasis is most apt to occur between the fifth and sixth or the sixth and seventh cervical vertebræ. It is often combined with a fracture. Dislocations of the vertebræ are best divided into (*a*) *dislocations by abduction or rotation, and* (*b*) *dislocations by flexion.* Under those by abduction or rotation are included the complete or incomplete unilateral dislocations forward or backward, and the bilateral dislocations in opposite directions. The majority of the unilateral are forward, there being only a few cases recorded in which it occurred in a backward direction. Under dislocations by flexion, are included bilateral forward or backward ones. The former is far more frequent, and follows extreme flexion of the neck. There are, as in the case of the unilateral abduction variety, but few cases of bilateral backward dislocations. The diagnosis of this class of injuries of the vertebræ, viz., dislocations, is very difficult. The majority of the symptoms are local, and there is little to distinguish them from a fracture. The evidences of displacement are the same, but there is no crepitus as in fracture. The latter sign may, however, be absent even in a fracture. Abnormal mobility might also be of value in the differentiation from a fracture, were it not for the fact that the neck is held so rigid that it is impossible to elicit abnormal mobility or crepitus, and further [illegible] contraindicated to manipulate the spine under these conditions.

The neck is held rigid and contracted in both fractures a[illegible]

cations. The chief diagnostic points of a dislocation are (*a*) the deformity; (*b*) the pain, and (*c*) the spinal cord symptoms.

(*a*) The deformity can often be recognized by passing the finger along the cervical spines, and also by palpating the transverse processes. The prominence or depression of a spinous process is often quite marked, allowance being made for the fact that one can seldom feel the upper cervical spines even in normal individuals. At times the displaced vertebræ can be felt through the pharynx.

(*b*) The pain varies greatly, but is generally quite marked, and referred along the course of the affected cervical nerves.

FIG. 547.—FRACTURE AND SUBLUXATION; CERVICAL VERTEBRÆ UNITED (J. Mason Warren collection, Warren Museum) (Walton).

(*c*) The spinal cord symptoms may, as in the case of a fracture, be due to hematomyelia or to the pressure of a fragment or displaced vertebra. The symptoms of compression are absent in a larger number of cases of dislocation, than of fracture; especially is this true of paralyses. If present, they are apt to be less extensive and less marked than in the case of a fracture. Immediate death may occur as the result of phrenic nerve paralysis. In general, however, the paralyses are incomplete, and anesthesia is often absent or unequal. It may be more marked on one side than the other. The paralysis may correspond entirely to that of a peripheral nerve. Paralyses may be

quite marked and then disappear gradually. In some cases the paraplegia, paralysis of the rectum and bladder, priapism, high temperature, vasomotor changes, and acute decubitus may resemble the same symptoms following a fracture (page 761).

Other nervous symptoms are localized muscular twitchings, general epileptiform convulsions, hyperesthesia, and neuralgic pains in the course of nerves that are compressed.

The *x*-ray may be of some value in confirming the diagnosis, but care must be used in interpreting the skiagraph. Skiagraphs of the cervical and upper dorsal regions usually show if dislocations of the vertebræ have occurred. The use of the *x*-ray is, however, very unsatisfactory to show fractures without much displacement in any portion of the spine.

Hematorachis and Hematomyelia.

These conditions are so frequently associated after traumatism that they will be described together. Meningeal hemorrhage (hematorachis) may be extradural or subdural. The symptoms of both are alike. In hematomyelia the hemorrhage usually takes place into the gray matter, but the white matter is not exempt. Both of these conditions occur most frequently in the cervical region.

The symptoms of hematorachis, when it occurs alone, appear more gradually than do those of hematomyelia. In both, the symptoms depend upon the tension, extent, and location of the clot.

The symptoms common to both conditions are the following: (*a*) Severe pain radiating along the compressed or involved nerve-trunks; (*b*) symptoms of motor and sensory paralysis; (*c*) paralysis of the bladder and anal sphincters.

The symptoms of hematomyelia are present, as a rule, immediately after an injury, and this is the only feature distinguishing it from hematorachis.

In traumatic cases the two are so frequently associated that it is almost impossible to make a differentiation.

The symptoms are usually most marked at the end of the first twenty-four hours. They subsequently improve, and disappear completely in four to six weeks. Death may, however, immediately result.

Both of these conditions can be distinguished from the spinal cord symptoms following fractures or dislocations by the fact that they develop more gradually, and, further, that they tend to disappear spontaneously within a short time.

Concussion of the Spine.

This condition has been the subject of considerable dispute ever since Erichsen, in 1871, published his treatise on "Spinal Concussion."

He described fifty-three cases of spinal injury, received chiefly during railway accidents, which had no external evidence of such injury. The list embraced cases of fracture, hematomyelia, meningitis, hysteria, and neurasthenia. To these he gave the name "railway spine," and this term is extensively employed by lawyers for litigants, even at the present time, to represent an imaginary clinical entity.

Oppenheim, in 1880, made a closer distinction between organic injuries and those not marked by histologic changes, and proposed the term "traumatic neuroses" for the latter class. About the same time Charcot taught and demonstrated that the nervous symptoms in these cases, apart from those attributable to organic lesions, were precisely the same as are presented in neurasthenia and hysteria. The latter two conditions may develop after a fright, or after a railway or other accident. They do not, however, differ in any degree in their symptoms or diagnosis from a neurasthenia or a hysteria, which do not follow trauma. Many of the symptoms develop immediately, and are so greatly improved after the settlement of a claim for damages as to have caused them to be termed *litigation symptoms*.

In some cases there is distinct simulation. A celebrated case is that of a patient who claimed to have had a dislocation of the atlas upon the axis, and had typical hysterical blindness, and paralyses of motion and sensation, shifting from one limb to the other. X-rays were shown in court which accurately resembled such a dislocation. X-rays were taken of a normal individual, and it was shown that it was possible to reproduce exactly the symptoms of the claimant who had voluntarily thrown the head forward while having a skiagraph taken so as to simulate a dislocation. For the diagnosis of neurasthenia and hysteria the reader is referred to text-books on nervous diseases.

Traumatic Spondylitis.

This interesting post-traumatic condition was first described by Schede and later by Kümmell. It is in reality a softening of the vertebral body following an injury, with the gradual yielding of the body and resultant angular deformity. It follows injuries of the same nature as those which cause the other post-traumatic lesions previously described. The distinctive feature of the disease is the fact that pain along the compressed nerves appears months to years after the injury. Accompanying these pains there are often paralyses of varying degrees, and the

gradual development of an angular deformity, or gibbus, similar to that observed in tuberculous spondylitis (page 778). In some cases there is a general increase of the curve of the spine. In these cases the diagnosis cannot be made until the deformity or paralysis appears, which occurs a considerable period after the injury.

The chief conditions from which it must be differentiated are simulation and a tuberculous spondylitis. The former is excluded by the objective evidence of the angular deformity or general increase of the curve of the particular region involved. The tuberculous condition is more frequent in early life, accompanied by muscular spasm and abscess formation, and there is less tenderness than in traumatic spondylitis.

Gunshot and Stab Wounds of the Spine.

The symptoms and diagnoses of both of these forms of injury do not differ from those of other traumatic conditions. Stab wounds usually cause contusion of the cord, producing in the majority of cases a partial paralysis of the Brown-Séquard type (see page 760).

Half of the cord is not always severed, but the surrounding degeneration produces the remainder of the symptoms.

In gunshot wounds one finds the symptoms of fracture of the body of the vertebra plus those of paralysis, or the signs of fracture of the arch or spinous process. One cannot tell whether the paralysis is due to the bullet itself or to compression by a splinter. The *x*-ray may be of some aid in this direction.

The cord symptoms differ in no manner from those following ordinary fractures or dislocations of the vertebræ. They may, however, disappear entirely.

Diseases of the Spine.

Tuberculous Spondylitis (Pott's Disease).

This and scoliosis are the two most frequent non-traumatic affections of the spine. It rarely involves any other part of the vertebra than its body, producing a gradual disintegration of the latter. In about half of the cases, an abscess is found clinically, whose pus gravitates along intermuscular planes, from the original focus. These abscesses usually present externally in certain definite places, according to whether the primary disease is in the cervical, dorsal, or lumbar regions (see below). The destruction of two or more adjacent vertebræ results in the formation of one of the most typical signs of the disease, viz., an angular deformity (see below). A complication of the disease

is its extension to the membranes of the spinal cord, the resulting pachymeningitis giving rise to pressure symptoms of varying degree.

Primary disease of two vertebral bodies in different, non-adjacent parts of the spine is rare. The two most frequent localizations of a tuberculous spondylitis are in the twelfth dorsal and first lumbar (dorsolumbar junction) vertebræ, and next in order in the seventh

FIG. 548.—METHOD OF EXAMINATION OF THE HEAD AND NECK IN ORDER TO DETERMINE THE PRESENCE OF AN INFLAMMATORY AFFECTION OF THE UPPER CERVICAL VERTEBRA.

The surgeon should stand behind the patient, grasping the head between the extended hands, the finger-tips being placed below the lower jaw. The head is then caused to bend forward and backward, eliciting pain during these movements. Such evidence of pain is ordinarily not to be obtained in these cases of disease of the atlas or axis, on account of the voluntary fixation of the spine on the part of the patient.

cervical and first dorsal vertebræ (cervicodorsal junction). *The most important diagnostic symptoms of the disease are:* (1) The reflex rigidity of the spine; (2) the referred pains; (3) the presence of an angular or more gradual deformity; (4) the formation of abscesses; (5) the symptoms of spinal cord involvement. *Of these the presence of the prominence, associated with muscular rigidity, and its resultant attitudes and*

gaits are sufficient to make a diagnosis if the diseases to be described (malignant tumors, fractures, etc.) are excluded.

1. *Rigidity of the Spine.*—If the disease is located in the upper cervical region (atlas or axis) the head and neck are either held in a wry-neck attitude or the head is rigidly fixed in the median line. Every effort to rotate the head or to flex the head upon the neck (Fig. 548) is resisted, or accompanied by great pain. The patient attempts to fix the head voluntarily, by supporting the chin upon the hands.

FIG. 549.—METHOD OF TAPPING HEAD IN ORDER TO DETERMINE TENDER POINTS IN SPINE.

In disease of the lower cervical or upper dorsal region, the chin is held raised, the muscles of the back of the neck and of the back itself are contracted and cause the spine to be held stiff and straight. It is difficult for the patient to lean forward or to pick up objects from the floor.

In disease of the lower dorsal and upper lumbar vertebræ the muscles of the back can also be felt to be contracted. The spine is held rigid, and this is most marked when the patient bends over or walks. The gait is characteristic. In the effort to fix the spine the patient will throw the shoulders and head back, and walk by sliding the feet along the floor, so as to move the pelvis and the lumbar spine as little as possible. There is also flexion at the hip, and the patient steps on the toes. In disease of the cervical and upper dorsal region the patient walks with head fixed in the median line, shoulders raised, and spine erect.

The rigidity in the dorsolumbar region is best tested by raising the limbs while the patient lies prone upon the table.

2. *Pains.*—The pain of Pott's disease is more often referred to distant points than to the diseased vertebra. It is usually referred to the terminations of the corresponding spinal nerves. In diseases of the cervical region, the pain is referred to the back of the head or neck, or to the mastoid region, or along the arms. In disease of the dorsal and lumbar vertebræ, the pains are referred to the peripheral ends of the corresponding intercostal and abdominal nerves. It is not uncommon for such patients to complain of stomach-ache, pains like those of a pleurisy, intercostal neuralgia, or lumbago, or pain in the bladder, etc. The pains are always worse at night, and are increased by any movements of the spine. In some cases the pain is elicited by tapping upon the head (Fig. 549) or pressing upon the spines.

FIG. 550.—METHOD OF PALPATION OF THE SPINOUS PROCESSES FOR TENDERNESS. (See text.)

3. *Deformity.*—This, when present, is sufficient to make a diagnosis. In acute cases there is accompanying muscular spasm and referred pains, while in subacute or chronic cases the deformity is usually present without rigidity, and the pain is minimal.

The deformity, or *gibbus*, as it is called, may be quite sharp and cause an angular prominence of the spines of only two or three vertebræ or it may involve a number of vertebræ. The curve in the latter instance, is a more gradual one. This is especially apt to be so in the more chronic cases. Accompanying this angular deformity there are

marked changes in the contour of the head and thorax, as well as a retardation of the general body growth.

4. *Abscesses.*—Although at autopsy a collection of pus is invariably found, it can be recognized clinically in only one-half of the cases. In cervical disease, the abscess is found either in the retropharyngeal space or in the lateral regions of the neck. In the latter location it simulates an abscess having its origin in caseous lymph-nodes, but is usually larger and accompanied by the spinal symptoms—rigidity and pain on movement.

In disease of the dorsal region the abscess may appear upon the back and simulate a lipoma (Fig. 154), or an abscess having its origin in disease of the ribs. Disease close to the dorsolumbar junction causes abscesses which may appear (*a*) in the lumbar region over the kidney, or (*b*) above Poupart's ligament, simulating a reducible oblique inguinal hernia, or (*c*) over Scarpa's triangle, simulating a femoral hernia (Fig. 552). In the two latter locations the detection of fluctuation, the absence of an impulse on coughing, and the spinal symptoms soon clear up the diagnosis.

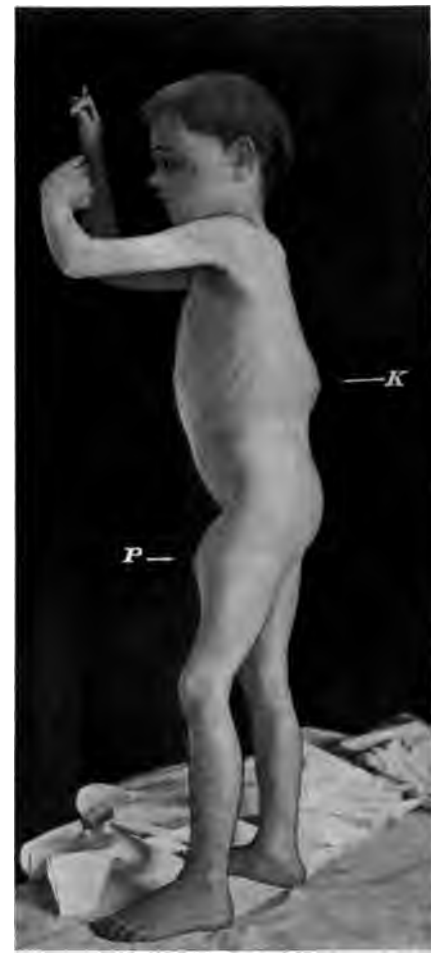


FIG. 551.—KYPHOSIS AT DORSOLUMBAR JUNCTION, DUE TO TUBERCULOSIS OF THE LAST DORSAL AND FIRST LUMBAR VERTEBRA.

K, Points to apex of kyphosis, or backward angle of deformity of spine; *P*, points to a large psoas abscess, the anterior view of which is seen in Fig. 552.

5. *Spinal Cord Symptoms.*—These are an infrequent complication, but occur especially often in the more acute cases. The motor paralysis is usually the most marked symptom. It varies from weakness to complete loss of power. The paralysis is at first of the flaccid type, but later spasticity with resultant contractures occur. The paralysis sets in gradually, but

may increase rapidly, with exacerbations. It often improves with betterment of the local condition.

In upper cervical disease the arms and legs are both paralyzed, and there may be dysphagia, etc. In these cases death may occur suddenly, following spontaneous dislocation of the atlas upon the axis. The sensory paralysis is very atypical because the posterior portions of the cord are but little involved. There may be anesthesia or hyperesthesia, or only paresthesia. The reflexes are exaggerated at first, but later are absent.

FIG. 552.—ENORMOUS PSOAS ABSCESS OVER SCARPA'S TRIANGLE IN BOY SUFFERING FROM TUBERCULOUS SPONDYLITIS OF THE DORSOLUMBAR REGION.

In addition to the chief diagnostic features of tuberculous spondylitis just enumerated, viz., rigidity, pains, deformity, abscesses, and paralyses, it is of great value to obtain a history of tuberculosis in the family or of foci elsewhere in the body (lymph-nodes, joints, lungs, kidney, testis, peritoneum, etc.). The general condition shows quite marked changes. The patients are emaciated and anemic. There is a difference between morning and evening temperatures of from one to three degrees.

Differential Diagnosis.—*Wry-neck.*—Disease of the cervical spine must be differentiated from the various forms of wry-neck. The principal features of the rheumatic, congenital, and inflammatory forms, the last named from inflamed lymph-nodes, have been fully considered on page 160.

Diseases close to the dorsolumbar junction must be differentiated from the following conditions:

Hip Disease.—This has been considered on page 724. The restriction of motion at the hip in Pott's disease is in only one direction,

viz., hyperextension, owing to contraction of the psoas. The lumbar spine, although held somewhat rigid in hip disease, as a compensatory condition, is arched and less fixed than in Pott's disease.

Other Forms of Backward Curvature or Kyphosis.—Rachitic kyphosis is a gradual one extending over the entire dorsal and lumbar regions. There is no muscular rigidity, and there are always other signs of rachitis (see page 678).

Senile kyphosis (Fig. 124) involves chiefly the dorsal vertebræ, and is also gradual. There is no rigidity or pain. Other conditions which require differentiation are scoliosis (page 784), hysterical spine (page 785), arthritis deformans of the spine (page 784), malignant disease (page 785), and acute osteomyelitis of the spine (page 784).

Iliopsoas contraction, due to inflamed lymph-nodes, may simulate a disease of the spine (page 784).

FIG. 553.—SCOLIOSIS.

Showing principal curvature to right in dorsal region, and compensatory, in opposite direction, in lumbar and cervical regions. The prominence of the posterior portion of the thorax well marked on side of curvature. The difference in the contour of the chest also to be noted.

SCOLIOSIS (LATERAL CURVATURE OF THE SPINE).

This is an affection which appears during the years of growth, *i. e.*, from the sixth to the sixteenth years. Often the first complaint is from the parents, who have noticed that the child carries one shoulder higher than the other. In the majority of cases the diagnosis can be readily made by inspection from behind when the patient is divested of the clothing down to the level of the hips (Fig. 553). The most frequent curve of the spine is that in which there is a convexity in the dorsal region, to the right (right dorsal scoliosis). The right shoulder is higher, the scapula on the side of the convexity stands out, and is also higher than its opposite. The thorax below the scapula on the same side is more rounded, and there is a corresponding enlargement on the left side of the front of the thorax.

There is a much wider space between the right arm and the side of the trunk than on the left side. If the spines of the vertebræ are marked

with ink the curvature becomes quite clear. There are always compensatory curves in the opposite direction above and below the primary one (Fig. 553). The cervicodorsal and lumbar curvatures are less frequent than the dorsal. Lateral curvature may result from various causes, viz.: (1) Rachitis; (2) a sequela of infantile paralysis; (3) torticollis; (4) occupation; (5) chest diseases, especially after empyema; (6) a sequela of sciatica; (7) as a result of faulty posture. The latter is the most frequent.

ARTHRITIS DEFORMANS OF THE SPINE (SPONDYLITIS DEFORMANS).

This occurs as a part of the general disease of the joints previously described (page 708). As elsewhere its chief clinical features are pains and gradually increasing stiffness of the spine. Gonorrhea is a not infrequent cause. The disease occurs oftenest in elderly persons, but may be one of the manifestations of a generalized arthritis deformans at any age (page 710). The patients at first complain of pains like those of rheumatism, especially referred along the cervical and branchial nerves. This stage is soon followed by gradually increasing rigidity, most marked in the cervical region. The patient is unable to flex or rotate the neck. In some cases flexion is possible, but there is inability to extend the neck (Fig. 548).

In many cases the cervical region is the last to be affected, the lower part of the spine being first involved. The spinal rigidity is often accompanied by the same condition in the hips. There is no angular deformity as in Pott's disease, the whole spinal column is more apt to be involved, and there is no tendency to abscess formation. Spondylitis deformans is a frequent complication of gonorrhea. The diffuse stiffness of the spine, the slight backward curve, the presence of the same conditions in the hip, knee, and other joints, as well as the absence of muscular rigidity, are the chief diagnostic points.

ACUTE OSTEOMYELITIS OF THE SPINE.

This rather rare affection presents no difficulties of diagnosis. The onset is a sudden one, with severe pain, high fever, tenderness on pressure, and muscular rigidity. The formation of abscesses occurs early, and is indicated by the appearance of redness, induration, and heat in the vicinity of the affected vertebræ.

TYPHOID SPINE.

This appears during convalescence from typhoid, and is most apt to involve the lumbar portion of the spine. There is localized tenderness and pain. Disturbances of sensation, such as paresthesia and hyperesthesia, are frequent. The diagnosis can be made from an acute form of tuberculous spondylitis, by the absence of angular deformity, and of abscess formation, as well as from the history of a preceding typhoid.

HYSTERICAL SPINE.

This occurs oftenest as the result of an injury, and has been previously discussed under the head of spinal concussion (page 776). It is a local spinal manifestation of a general neurasthenia. By careful and repeated examinations one can readily eliminate any or all of the other forms of genuine spinal disease.

There is complaint of tenderness, which is often greatly exaggerated. There is no true rigidity, although some may be feigned, and can be discovered when the attention is diverted. Pressure over the same spinous process will at one examination be said by the patient to be very painful and later not noticed.

TUMORS OF THE SPINE AND SPINAL CORD.

Neoplasms, whether they arise from the vertebræ, from the meninges, or from the cord itself, can, as a rule, only be recognized *by the symptoms resulting from pressure upon the spinal nerves and cord.*

Schlesinger has recently collected 151 cases. Of these 104 involved the vertebræ primarily, 4 grew into the spinal canal from without, 11 arose from the dura, 4 from the piaarachnoid, 5 from the nerve-roots, and 20 were intramedullary.

As a rule, all of these tumors are of more diagnostic, than therapeutic interest. The majority of those which arise from the vertebræ are of secondary carcinomatous nature. The latter are frequent after primary growths in the breasts, thyroid, and prostate. Those which are not metastatic are primary fibromata or sarcomata of the bodies. The most frequent meningeal and intramedullary growths are the gumma, tubercle, glioma, and sarcoma. The gliomata give rise to a clinical picture described as syringomyelia (page 717).

The first symptom to attract the attention of the patient, in all of these neoplasms, is pain.

The pains affect a single spinal nerve or a pair. *Often a persistent unilateral or bilateral intercostal neuralgia is one of the earliest symptoms.* At first the pains are mild, but may become sharp and lancinating, or remain as a constant dull ache. These pains are at first accompanied by hyperesthesia over the area of distribution of the nerve. This neuralgic stage may persist for months to years, and the patient be treated for neurasthenia, etc., until signs of motor irritation and

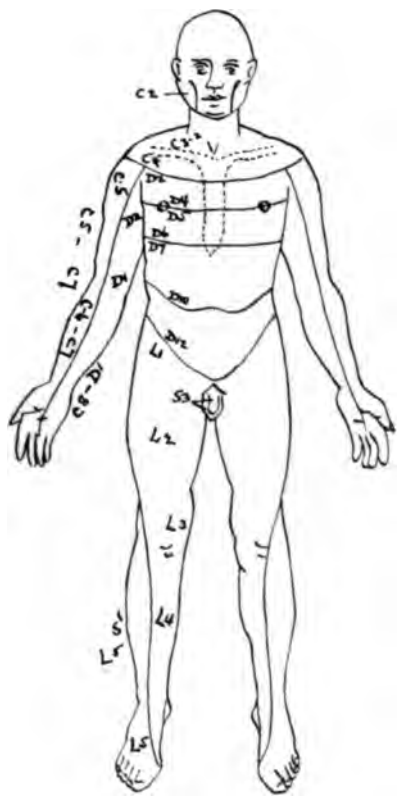


FIG. 554.—CUTANEOUS NERVE SUPPLY TO THE ANTERIOR SURFACE OF THE BODY (Seiffer).

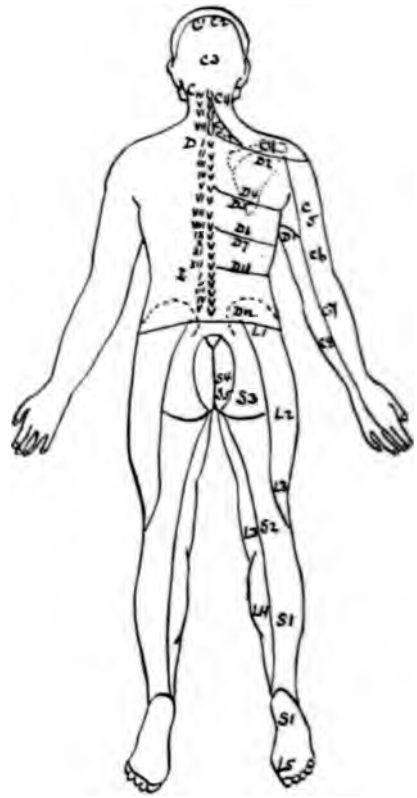


FIG. 555.—CUTANEOUS NERVE SUPPLY TO THE POSTERIOR SURFACE OF THE BODY (Seiffer).

paralysis appear. The symptoms of motor irritation, like twitchings, spasms, and rigidity, are soon replaced by muscular weakness and finally by complete paralysis. The latter is at first apt to affect only one extremity, but the opposite one is soon involved, so that a paraparesis or paraplegia develops.

The sensory symptoms most frequently correspond to the Brown-Séquard type (page 760), but the anesthesia is also frequently bilateral.

The reflexes below the level of the lesion are markedly increased, and this exaggeration follows the paralysis closely, the reflexes being lost when the compression is total. There is early involvement of the sphincters of the bladder and rectum, as well as the development of extensive decubitus. To locate the seat of the tumor a knowledge of the areas of cutaneous sensation supplied by the various spinal segments is of the greatest importance (Figs. 554 and 555), as showing the upper levels of the dysesthesia.

The diagnosis depends upon a knowledge of the more or less regular

FIG. 556.—FISTULA OF COCCYGEAL REGION LEADING INTO A DERMOID CYST.
The arrow points to the black spot which represents the opening of the fistula.

order and gradual appearance of the symptoms, viz.: (*a*) Neuralgic pains; (*b*) monoplegia, later paraplegia; (*c*) anesthesia; following motor paralysis; (*d*) exaggerated, and absence of reflexes. The presence or history of a primary growth elsewhere is of great value.

From Pott's disease malignant disease can be differentiated by the fact that the deformity when present is not angular, as in Pott's disease, but more rounded. In those tumors which arise from the cord itself there is no deformity, only neuralgic pains and muscular stiffness. The pains are never as severe in Pott's disease as in tumor. The symptoms

of tumors of the cauda equina do not differ from those of injuries of the same (page 764).

SACROCOCCYGEAL TUMORS.

A number of interesting congenital conditions are found in the region of the sacrum and coccyx. They may be of three varieties:

1. *Teratomata.*—These are irregular, pendulous tumors attached to the posterior surface of the sacrum or coccyx. In one class rudiments of the skeleton and of the different viscera are found. These are remnants of a parasitic fetus, which has failed to develop. In another class there is a great variety of tissues which do not, however, represent any single organ.

2. *Cystic Tumors Behind the Rectum.*—These are found between the rectum and sacrum. The majority have their origin in persistent remnants of the post-anal gut and neurenteric canal. The unilocular variety form large cysts, and may project into the rectum. The multilocular form is made up of a number of cysts, each containing a rope-like substance resembling mucus. Dermoids also occur within and behind the rectum, and may attain a large size.

3. *Sequestration Dermoids.*—These occur over the sacrum and coccyx, and allied to them are the sinuses and dimples which occur here (Fig. 556). The sinuses open near the tip of the coccyx.

CHAPTER VII.

POSTOPERATIVE COMPLICATIONS.

Complications following an operation have assumed such importance since the scope of operative interference has been so greatly widened that it is essential for every surgeon to be able to recognize them as early as possible. They may be divided in one of two ways, viz.:

(*a*) According to the individual operations or regionally, *i. e.*, the part of the body operated upon.

(*b*) According to the most prominent symptom or the organ involved in the complication.

The latter classification seems the most satisfactory from a diagnostic point of view and will be followed here. According to this mode of division the most important postoperative complications are:

1. Hemorrhage.
2. Shock and collapse.
3. Infection, not including peritonitis.
4. Pulmonary complications.
5. Cardiac complications.
6. Hepatic complications.
7. Gastro-intestinal complications, including postoperative ileus and peritonitis.
8. Postoperative ileus.
9. Postoperative peritonitis.
10. Renal complications.
11. Circulatory complications (thrombosis, etc.).
12. Miscellaneous postoperative complications.

Some of the above have been considered as complications of injuries on page 601.

HEMORRHAGE.

Hemorrhage following an operation may occur from the wound itself in one of three ways:

(*a*) As the result of imperfect hemostasis, either from ligating bleeding vessels too loosely or not having secured a sufficient number of bleeding vessels, the temporary closure by clots being disturbed through

movements of the patient. Subcutaneous veins and those of the muscular structures are very apt to bleed after the patient has been placed in bed, unless the larger veins have been ligated.

(*b*) As the result of constitutional causes. In this group belong those unavoidable hemorrhages which occur as the result of hemophilia and long-continued jaundice.

(*c*) As the result of infection of the wound. The thrombi, which obliterate the cut ends of the vessels, become disintegrated as the result of a purulent softening due to microörganisms. This was formerly called secondary hemorrhage and occurred more frequently than at present, when septic infection is rare.

(*d*) Hematemesis. A number of cases have been described, during recent years, in which capillary hemorrhages have taken place into the stomach, after operations upon the appendix and gallbladder. Such hemorrhages cannot be interpreted as the result of a faulty technique, but are in all probability the result of multiple emboli carried from the infected gallbladder or appendix into the circulation, causing hemorrhage by rhexis, of the smaller vessels of the stomach. These patients have recurrent attacks of vomiting which is brownish and shows the presence of blood by the appropriate chemical tests. The relation of these recurrent gastric hemorrhages to acute postoperative dilatation of the stomach will be considered on page 800.

Hemorrhage may take place after operations either (*a*) in such a way that it can be recognized at once by the reddish staining of the dressings, accompanied by increasing symptoms of anemia, *i. e.*, *external hemorrhage*, or (*b*) there may be no escape of blood from the wound or the latter may not be accessible to observation. Such postoperative bleeding is apt to follow intraabdominal operations or those upon the stomach or rectum or bile-passages.

These last-named hemorrhages may be properly termed *concealed or internal*, since they can only be diagnosed by recognizing the symptoms characteristic of internal hemorrhage in general, viz., those of rapidly increasing anemia and the other symptoms, such as recurrent attacks of syncope, thirst, restlessness, and rapid, empty pulse.

The diagnosis of the actual existence of the first clinical variety, viz., external hemorrhage, presents no difficulty. The blood is seen escaping either in large quantity, or there is constant oozing which frequently resists all of the ordinary methods of treatment. At times, a gradually increasing hematoma may be the expression of this form of postoperative hemorrhage.

In cases where the hemorrhage is due to constitutional causes, like

hemophilia, inquiry into the previous history of the patient himself or of the family will often result in a history of frequently recurring obstinate hemorrhages from the slightest of causes.

Hemorrhage due to persistent jaundice, almost invariably follows gallstone operations, and may often be recognized as such by an examination of the coagulation time of the blood before operation (see page 812), this being greatly decreased.

Hemorrhage as the result of local wound sepsis appears much later than either of the two preceding, and is accompanied by such marked local signs that its recognition is not difficult.

The hemorrhage spoken of as concealed or internal is much more difficult to recognize than any of the above. It may follow any operation in a serous cavity, such as the brain, pleura, or peritoneum. In the brain, the symptoms are those characteristic of cerebral compression (see page 38). In the peritoneal cavity, the symptoms resemble those following rupture of the tube in an extrauterine pregnancy, viz., gradually increasing pallor, soft, thready pulse, restlessness, and great thirst. Locally there are signs of irritation, from the presence of free blood in the peritoneal cavity. These symptoms of peritoneal irritation are rigidity of the abdominal wall, at first localized, but gradually becoming quite diffuse, accompanied by tenderness on pressure, and a moderate amount of tympanites (from paresis of the intestinal muscles). These symptoms are the same as those of a beginning peritonitis, and the question may be asked, How can the diagnosis of internal hemorrhage be made from those of a beginning septic peritonitis? The answer is, that if the hemorrhage is not sufficiently marked to produce signs of general anemia, a differentiation in the early hours is impossible. Later on, *i. e.*, after six to twelve hours, the continuation and increase in gravity of the peritoneal symptoms, unaccompanied by those of general anemia, indicate septic infection. In some cases both sepsis and hemorrhage may be combined and the symptoms of hemorrhage in the early hours after operation be followed by those of peritonitis later.

In general, it may be said that the signs of internal hemorrhage appear soon after an operation, *i. e.*, in the first six hours, while those of infection occur at a later period.

A gradual fall in blood-pressure, accompanied by a steady decrease in the percentage of hemoglobin and of the number of red corpuscles, may also be of aid in distinguishing hemorrhage from postoperative peritonitis. The differentiation of shock from both of these conditions, is considered under postoperative peritonitis and shock respectively.

Hemorrhage may occur after operations like a gastro-enterostomy or operations upon the rectum, like hemorrhoids, etc. The bleeding may

take place into the lumen of the stomach or bowel in the first-named class of operations or into the rectum in the latter.

The early recognition of such cases is often impossible except from the actual inspection of blood, either vomited or passed with a bowel movement. The reason for this is that such a passage of blood may not occur until the patient is almost exsanguinated. The only manner in which to diagnose such a concealed hemorrhage before either a bloody vomit or a tarry stool occurs, is by watching for the ordinary signs of internal hemorrhage. These are (*a*) gradual or rapidly increasing pallor of the skin and visible mucous membranes (lips, gums, tongue, and conjunctivæ); (*b*) restlessness, often accompanied by delirium or stupor; (*c*) great thirst; (*d*) the pulse becomes soft and very weak and rapid; (*e*) rapid fall of blood-pressure. The rate is not necessarily increased, since Nature's effort to check the hemorrhage is by the gradual onset of syncope. When hematemesis or evacuations of large quantities of fresh or old tarry blood take place and are accompanied by these signs of anemia, the diagnosis of concealed hemorrhage is not difficult.

SHOCK AND COLLAPSE.

The diagnosis of shock as a complication of injuries has already been referred to (see page 789). A similar condition may follow an operation, at times resulting in the death of the patients. The essential factor, as Crile has shown, is the exhaustion of the vasomotor centers, causing in the blood to collect in the splanchnic area and producing a fall in general blood-pressure. The heart is affected secondarily through the fall of blood-pressure, causing stagnation in the great venous trunks, and thus interfering with the action of the heart.

Postoperative shock is most apt to follow prolonged operations, and is especially frequent after those upon the viscera in the upper half of the abdomen. Collapse or syncope may follow operation, and is also due to a fall in blood-pressure, but from a different cause. The cause may be a sudden paralysis of the vasomotor centers, resulting from some violent afferent nerve stimulus, or it may be due to a sudden loss of blood. The clinical conditions described under hemorrhage should not be called collapse, since the vasomotor centers are intact. When, however, collapse following a severe hemorrhage has persisted for a considerable time, it begins to change into the condition of true shock, as the vasomotor centers become exhausted from their efforts to maintain the blood-pressure at the same level.

The chief symptoms of postoperative shock are the same as those of shock following injury. These are (*a*) marked pallor and coldness of the

skin and visible mucous membranes, accompanied by a slight tinge of cyanosis; (*b*) a small, irregular, and rapid pulse; (*c*) a stuporous or apathetic appearance of the patient.

The symptoms vary according to the cause. If they are the result of a sudden vasomotor nerve paralysis, there is almost complete arrest of the heart's action, marked pallor, dilated pupils, cold sweat, cold often slightly cyanotic extremities, feeble or absent respiration, and almost complete loss of consciousness. If the collapse is due to severe hemorrhage, these symptoms differ only in having appeared after a period during which the signs of such hemorrhage, such as anemia, etc., predominated. In some cases it is almost impossible to determine whether the condition of the patient is due to hemorrhage or shock. This has already been referred to in the diagnosis of concealed or internal hemorrhage.

In general, shock is more apt to follow prolonged operations or those upon the brain, genitalia, abdominal viscera, etc. The restlessness pallor, and weakness of the pulse are not nearly as marked in shock as in hemorrhage.

In some cases, it is very difficult to distinguish myocardial symptoms, such as a rapid, weak pulse, from those of shock.

INFECTION AS A COMPLICATION OF OPERATION.

Infection, like hemorrhage, may be recognized either through visible local signs when they are combined with those of a more constitutional nature, or the latter may predominate to such an extent that the local signs become insignificant.

The most important of the general signs which indicate infection is a rise of temperature. In the majority of patients, there is normally a slight rise of temperature for the first twenty-four to thirty-six hours after an operation. It is well to remember that in children this postoperative aseptic fever is relatively higher than in adults, and may be accompanied, especially in nervous children, by an increased pulse-rate, which would be alarming under other circumstances.

The temperature in the first thirty-six hours varies greatly. It is usually from 99° to 101° F., rarely higher. The rise takes place within twelve hours after the operation, dropping to normal a few hours later. It is supposed to be due to the absorption of fibrin ferment from the wound, and is called, for lack of a more exact name, "ferment or aseptic fever." If, however, the rise of temperature should recur upon the evening of the second day after the operation, suspicion should be aroused that infection has taken place. This secondary rise or continuation of the immediate postoperative fever will remain for a variable period, according to the nature of the infective lesion, and will usually be accompa-

nied by local signs indicative of the virulence of the infection. The various septic complications of an operative wound differ in no particular from those following an injury. It will, therefore, not be necessary to repeat here what was said on pages 607 to 622 about sapremia, pyemia, and the other infectious wound diseases. At times, however, infection may occur in a wound with very little, if any, fever, owing to the low grade of virulence of the organisms.

After operations within the cranial, pleural, or peritoneal cavities infection of the corresponding serous membrane may occur. The symptoms and recognition of these complications require no special mention, since they differ but little, except in the history, from those originating without such operative wound. The diagnosis of postoperative septic peritonitis will be considered in connection with that of postoperative ileus.

PULMONARY COMPLICATIONS FOLLOWING OPERATIONS.

The increased frequency of these of recent years, has directed the attention of surgeons not only to their early recognition, but to the study of their causes and prevention. It is not within the province of this book to discuss the latter. It may be said, however, that patients who are suffering from a bronchitis should be given nitrous oxid as an anesthetic. It can be administered for an hour or longer if necessary. The tendency to get patients out of bed earlier has also diminished the percentage of pulmonary complications. The frequency with which the various forms of postoperative pulmonary complications occur and their relative influence on results are well shown in a recent publication of Bibergeil.[1] He found 283 pulmonary complications, *i. e.*, 7.2 per cent., in 3909 abdominal operations from Körte's clinic.

Of these 815 were operations above the umbilicus.
2625 were operations below the umbilicus.
469 were operations both above and below the umbilicus.

These complications were:

		Mortality.
1. Pneumonia (lobular, lobar, hypostatic)	135	1.1 per cent.
2. Pulmonary embolism	12	0.3 " "
3. Pulmonary infarcts	9	11.0 " "
4. Bronchitis	82	
5. Pulmonary abscess	12	
6. Dry pleurisy	3	
7. Pleurisy with effusion	16	
8. Empyema	13	

9. In addition to these mentioned, among quite rare pulmonary complications are gangrene and acute edema.

[1] "Archiv für klinische Chirurgie," vol. lxxviii.

For every hundred abdominal operations there were 3.5 per cent. pneumonias, either lobar, lobular, or hypostatic. This corresponds to the relative frequency in other large German clinics. The frequency of pulmonary complications is, of course, greatest in advanced life, or where there has been a preëxisting bronchitis, etc.

That postoperative pulmonary complications are not always the result of a general anesthetic, like ether, is demonstrated by the frequency with which they occur after local anesthesia.

Pulmonary complications are, as stated above, most frequent after laparotomies, but they may occur as a result of almost any operation, such as operations in the mouth, herniotomies, ligation of varicose veins, etc. They are especially frequent after incarcerated or strangulated herniæ.

The most common modes of origin are (*a*) by aspiration of mucus or vomitus; (*b*) by the detachment, from the field of operation, of thrombi which are carried to the lungs; (*c*) migration of organisms through the diaphragm.

The recognition of these various forms of pulmonary complications usually presents no difficulties, since *their physical and general signs differ but little from those observed in non-operated cases.*

The lobular and hypostatic forms of pneumonia occur far more frequently than does the lobar or croupous variety. The latter affects the right lower lobe oftener than any other lobe.

Lobular and lobar pneumonia, pulmonary edema, pleuritis, and bronchitis belong to the complications which occur within the first week after an operation. Pulmonary infarcts, embolism, abscess, gangrene, empyema, and hypostatic pneumonia usually occur at a later period. In a few cases, pulmonary edema has followed the administration of the anesthetic. One of the most distressing of these complications is *pulmonary embolism.* This may occur at such a late period, *e. g.*, when the patient is getting up, that all thought of any complication has been dismissed. A thrombus becomes detached, apparently without cause, from a vein in the vicinity of the field of operation, and is swept through the right heart into the pulmonary artery. It lodges in one of the primary bifurcations of the latter vessel (Fig. 557), and gives rise to most serious symptoms and often causes death.

Some of the emboli may not occlude the vessel, but float to the periphery of the lung and cause subpleural patches of embolic lobular pneumonia or pleurisy. In 40 of 66 cases of pulmonary embolism collected by Lotheissen (quoted by Gebele[1]) the origin of the thrombus was in the veins of the leg; the next most frequent seat was the pelvic veins.

[1] Gebele: "Beiträge zur klin. Chir.," vol. xiv.

The recognition of the more serious form of pulmonary embolism is important. The symptoms usually appear quite suddenly at a time when least expected. There is great dyspnea, accompanied by cyanosis and shallow, rapid respirations. The pulse becomes rapid and almost imperceptible, and death may ensue within a few minutes. In cases in which one recovers from this condition, the above symptoms gradually diminish in severity. The physical signs are practically *nil*.

The occurrence of phlebitis following abdominal operations is considered on page 806.

CARDIAC COMPLICATIONS.

A patient with a normal heart very rarely develops postoperative cardiac complications. The effect of the anesthetic is transitory, as a rule, leaving no trace after the patient has recovered consciousness. Even under pathologic conditions, it has been found that the anesthetics most frequently given, ether and chloroform, have no ill effects in the majority of cases of valvular lesions. It is only in cases of myocarditis that postoperative complications are liable to follow. In these death may occur as a result of the myocarditis, in from one to several days after the operation, the severity of which has been increased by the operation. Under the latter conditions, in elderly patients, one not infrequently notices marked irregularity in the rhythm and volume of the pulse following an operation. In general, the signs of such a myocarditis are an irregular, weak, and rapid pulse with feeble heart tones and evidences of cardiac dilatation.

HEPATIC COMPLICATIONS.

1. **Icterus.**—This may occur from a number of different causes as follows:

(*a*) It may be a symptom of an acute gastro-enteritis, occurring as a result of the toxic effects of the anesthetic upon the digestive tract.

(*b*) It has been described as a direct result of the toxic action of chloroform upon the blood. This is very rare, if it ever occurs.

(*c*) It may be a symptom of one of the postoperative complications to be described, such as cholemia or acid intoxication.

(*d*) Postoperative obstruction of the common duct by a gallstone, which has either been overlooked during an operation for gallstones, or has passed down into the common bile-duct from the intrahepatic bile-ducts.

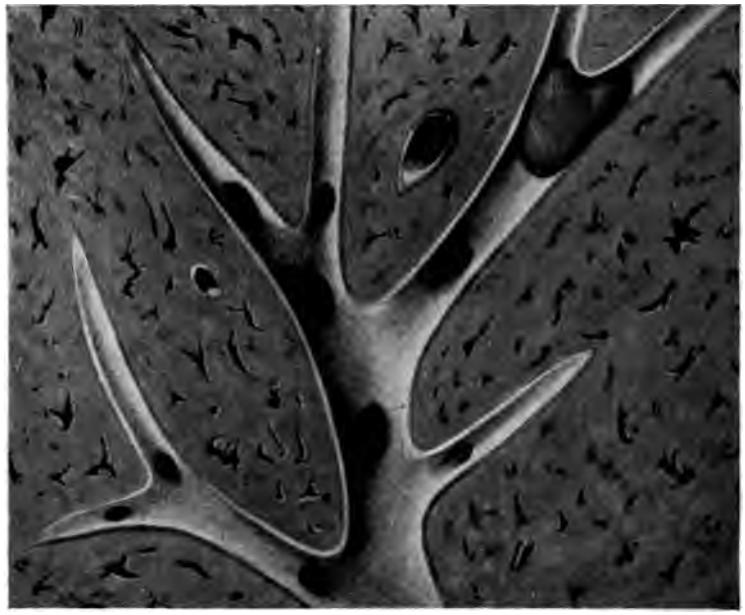


FIG. 557.—SECTION OF LUNG SHOWING RAMIFICATIONS OF PULMONARY ARTERY AND LODGMENT OF AN EMBOLUS IN BIFURCATIONS OF THE VESSEL.

This is the condition found at autopsy in cases of pulmonary embolism. (See page 795.)

The diagnosis of the cause of the jaundice in a given case can only be made by a careful study of the accompanying symptoms.

2. **Acid Intoxication.**—This condition is placed under the head of hepatic complications because in a number of cases, in which the liver has been examined microscopically, acute fatty degeneration in some cases [1] and necrotic changes in the parenchyma in others [2] have been found.

This complication has been given various names, such as cholemia, acidosis, acetonemia, and acid intoxication. The last-named term seems the most appropriate for the present, although the condition is one of a toxemia due to hepatic insufficiency. It may be the result of a number of toxic agents, viz., anesthetics (especially chloroform), poisons, infective microörganisms, and pregnancy. These affect the secreting cells of the liver, and prevent their normal function. Acetone and diacetic and oxybutyric acids are found in both the blood and urine. They are, however, to be regarded as by-products, and not as the essential causes.

They are of various degrees. In the milder form, the recovery is rapid, showing as symptoms only restlessness, mild delirium, and drowsiness after the anesthesia. Bevan and Favill have collected 30 cases, of which 28, including their own, were fatal. Twenty-three of the 30 followed chloroform anesthesia. In the graver cases the symptoms are delirium, vomiting, restlessness, convulsions, coma, Cheyne-Stokes respiration, cyanosis, and icterus in a variable degree. The most characteristic symptoms, according to Brewer,[3] are a sweetish odor of the breath, delirium, and rapidly fatal coma. According to Kussmaul, to these symptoms are to be added "air hunger," *i. e.*, deep breathing accompanied by a bright red color of the mucous membranes. In the case described by the writer in 1901, the chief symptoms were delirium, coma, intense jaundice, and very high temperatures up to 108° F. These symptoms of acid intoxication have appeared from ten to one hundred and fifty hours after operation.

GASTRIC COMPLICATIONS.

The most frequent gastric complications are:

1. Vomiting.
2. Hematemesis.
3. Acute dilatation of stomach.

[1] Bevan and Favill: "Jour. Amer. Med. Assoc.," Sept., 1905.
[2] Eisendrath: "Jour. Amer. Med. Assoc.," Nov., 1901.
[3] "Annals of Surgery," vol. xxxvi.

1. **Vomiting** after operation may occur at various periods, and the diagnosis of its cause rests upon three factors:

(*a*) Length of time which has elapsed since the operation.

(*b*) Character of vomitus.

(*c*) Accompanying symptoms.

(*a*) *Length of Time after Operation.*—If the vomiting is due to the anesthetic, it usually occurs before the patient has become fully conscious, *i. e.*, in the first twelve to twenty-four hours after operation. Ether and chloroform differ somewhat in this respect. If due to ether, it occurs usually before the patient regains consciousness and is brief in duration. It begins early and ends early. With chloroform, the nausea and vomiting may begin immediately after operation, but more commonly they begin late, being delayed as long as twenty-four hours. Postoperative chloroform vomiting is quite persistent, often lasting three to four days. If vomiting after either anesthetic persists longer than twenty-four to forty-eight hours after operation, other postoperative complications must be thought of, and search made for symptoms which will either confirm the suspicion of their presence, so that a diagnosis may be made, or exclude their presence. One of the most frequent causes of prolonged postoperative vomiting, is defective excretion of urea, and not infrequently uremic complications are overlooked until too late to be remedied.

Persistent nausea and vomiting as symptoms of nephritic complications will be referred to again, under renal complications. Other causes of vomiting appearing later than the ordinary post-anesthetic vomiting may be due to acute dilatation of the stomach, postoperative ileus, and peritonitis. The diagnosis can only be made in such cases from the character of the vomitus and the symptoms characteristic of these conditions. Let it not be forgotten that occasionally chloroform vomiting will persist for a number of days, accompanied by violent headache and great depression. The majority of these cases are due to renal complications. Another cause of late postoperative vomiting is that of acid intoxication (see page 798).

Obstinate postoperative vomiting has frequently been observed following abdominal operations in neurotic individuals.

(*b*) *Character of Vomitus.*—The vomitus which occurs after ether or chloroform anesthesia consists of mucus, or mucus mixed with bile. If it persists for some hours after anesthesia, it may consist of bile alone. In operations about the mouth, nose, or throat the vomiting of large amounts of blood, *i. e.*, hematemesis, may be a complication of an abdominal operation and is referred to later. In acute dilatation of

stomach, which will also be described, the vomitus is a brownish sour liquid, which attracts attention on account of the large quantities brought up with each effort. The diagnosis of these conditions can be made from the brownish character of the vomitus, from the accompanying symptoms of collapse and the distention of the upper abdomen. The vomiting occurring as a result of postoperative peritonitis or ileus will be described on page 802.

(*c*) *Accompanying Symptoms.*—The vomiting due to ether or chloroform is seldom accompanied by other symptoms than those of nausea or vertigo. If the vomiting due to one of these anesthetics persists for a number of days, it is accompanied by great mental depression and anxiety, hollow sunken eyes, retracted abdomen, diminished excretion of urine, dry skin, etc. If vomiting is due to other causes, such as postoperative nephritis, ileus, peritonitis, acid intoxication, or acute gastric dilatation, the symptoms are those described under the respective heads in this chapter.

2. **Postoperative Hematemesis.**—Reference has already been made under the head of "hemorrhage" to the vomiting of blood, occurring as the result of an improperly performed gastro-enterostomy. One of the first to call attention to this condition was von Eiselsberg, in 1899. He reported a number of cases in which it followed ligation of the omentum. Since this time, a number of others have directed attention to this postoperative complication. It has been found to follow a variety of abdominal operations, even on organs like the appendix. The etiology of the condition is still a matter of dispute. The vomiting of blood begins within the first twenty-four hours after the operation, there being usually an interval between the vomiting which is due to the anesthetic and that of the hematemesis. Usually an ounce of intensely acid blood is vomited at frequent intervals, but in some cases symptoms of acute dilatation of the stomach appear (see page 800) in which the patient vomits a brownish fluid in large quantities, say a pint or more at a time. The examination of this fluid reveals the presence of blood as the cause of the color and an excess of acid. The etiology of such postoperative acute dilatation is discussed on page 800. The general condition is similar to that of an intense toxemia, with rapid, small pulse, and cold, moist skin. In some cases the acute gastric dilatation symptoms predominate (see page 801). This condition is followed by a rapidly progressing collapse.

The diagnosis presents no difficulty, especially if the black blood vomited at frequent intervals is accompanied by the symptoms of toxemia mentioned above. The only condition with which it could

possibly be confused, is acute dilatation of the stomach. In this, the vomitus is thin and brownish and the symptoms of collapse appear much more rapidly. The enormous swelling of the upper abdomen, with displacement of the lower viscera and interference with respiration, are also important diagnostic signs of acute dilatation.

3. **Acute Gastric Dilatation.**—This condition was formerly considered to be a very rare complication, but more recent observation has shown it to occur comparatively frequently. This later view is the result of closer observation and earlier diagnosis. The generally accepted theory of etiology is that it is the result of a paralysis of the muscles of the stomach wall, either of central or local origin, and may follow any abdominal operation, especially those upon the gallbladder and kidney.

The earliest and most common symptom is nausea and vomiting. This may begin soon after recovery from the anesthesia, increasing in severity in proportion to the degree of dilatation. In other cases it may not begin until the second or third day following the operation.

The vomiting can be distinguished from the ordinary postoperative vomiting by the gradual increase in the quantity of fluid. Enormous quantities of thin, brownish, sour fluid are vomited. The emesis is accompanied by symptoms of collapse. The upper half of the abdomen is at the same time much distended and tympanitic on percussion. The temperature is either normal or subnormal, the pulse increased in frequency, and the urine either greatly diminished or there is complete suppression. The heart is displaced upward (see Fig. 558) by the greatly dilated stomach. Percussion over the precordium and left side of the chest shows a marked tympanitic note. The displacement of the heart and left lung is the cause of the rapid, weak pulse, the cyanosis, and dyspnea so characteristic of these cases. Through the stomach-tube, an enormous quantity of brownish fluid escapes, great improvement occurring after gastric lavage. The change in contour of the upper half of the abdomen, and the decreased area of tympany after every expulsion of vomitus, show that this fluid is not free in the peritoneal cavity. Many of the milder cases recover spontaneously, although the majority end fatally unless speedy relief, by gastric lavage, etc., is given.

The differentiation of vomiting due to acute postoperative gastric dilatation from that due to postoperative septic peritonitis and postoperative ileus is made as follows:

When vomiting occurs after the first twelve hours, it may be (*a*) result of the anesthetic; (*b*) due to an acute gastric di

an acute duodenal obstruction (gastromesenteric ileus); (*d*) due to a postoperative ileus; (*e*) due to a beginning general peritonitis. How can we differentiate these five postoperative conditions? If the vomiting is due to the anesthetic, it should begin to diminish in frequency during the second twelve hours after the operation. In addition, the vomitus consists simply of mucus with a small amount of bile. There is no abdominal distention, and when the high rectal tube is inserted or an enema is given, the patient is able to expel flatus. The second and third conditions, viz., acute gastric dilatation and gastromesenteric ileus, cannot be differentiated so that they will be considered together. In both the onset of vomiting is preceded by restlessness. The vomiting begins within twelve to twenty-four or thirty-six hours after the operation. One of the most characteristic symptoms of these cases of acute gastric or duodenal dilatation is the vomiting of large quantities (from 8 to 16 ounces) of a sour, brownish fluid. Then in a short time as large a quantity of the same fluid is vomited apparently without much effort. The patient's general condition [illegible] great anxiety and prostration.

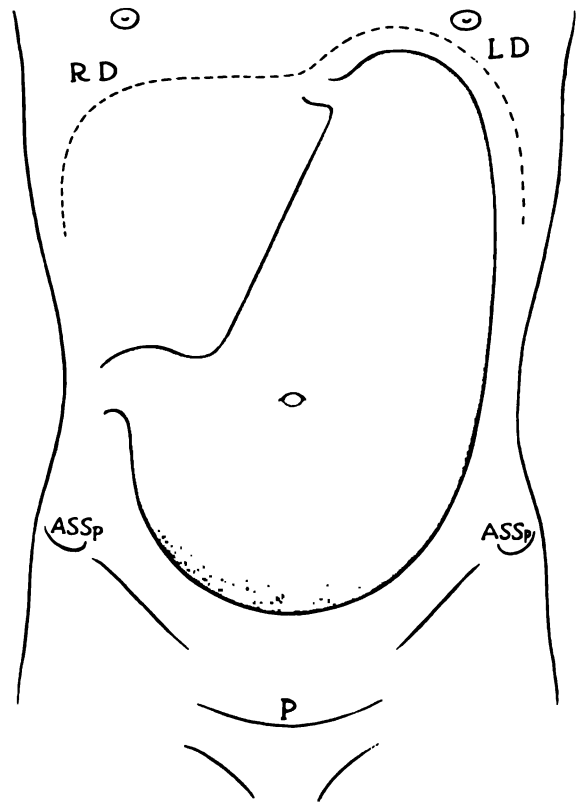


FIG. 558.—OUTLINE OF ACUTELY DILATED STOMACH ON ABDOMINAL WALL.

Note how far the great curvature lies below the umbilicus and how the fundus pushes up the diaphragm. Displacements of the intestine in a downward direction and of the left dome of the diaphragm in an upward direction cause an increased area of tympany in the upper half of the abdomen and the other symptoms described on page 800 characteristic of acute gastric dilatation. RD, right dome of diaphragm; LD, left dome of diaphragm; ASSp, anterior superior spine of ilium; P pubes.

The lips are cyanotic, extremities cold and clammy. The respirations are labored and shallow and the pulse rapid and small.

In addition to the vomiting of large quantities of brownish, sour fluid and the rapid onset of collapse symptoms, examination of the abdomen and the insertion of a high rectal tube, combined or not with the administration of an enema, will soon clear up the diagnosis. In acute gastric or duodenal dilatation the upper abdomen, from the umbilicus upward, is greatly distended, and percussion shows a marked tympanitic note. The area of tympany extends upward to such an extent that there is scarcely a trace of cardiac dullness or of pulmonary resonance (Fig. 558). This displacement of the heart as the result of the pushing upward of the diaphragm by the distended stomach explains the cyanosis, dyspnea, and feeble heart action. The lower abdomen is not distended, as in a beginning postoperative ileus, nor is there rigidity and tenderness present, as would be the case in a postoperative peritonitis. If the symptoms are the result of an acute gastric dilatation, rapid improvement will follow the lavage of the stomach. If the symptoms recur, as is often the case, repeated lavage will again give relief. If the high rectal tube is passed or an enema given in acute gastric dilatation, flatus or feces will be expelled. In postoperative ileus and peritonitis there is early and absolute obstruction, no feces or gas being obtained through the use of rectal tubes or enemas.

In the fourth condition, viz., postoperative ileus, the vomiting is in smaller quantities and not accompanied by such an amount of dyspnea, cyanosis, and collapse symptoms in the early hours as in gastric dilatation. The abdomen is more uniformly distended and negative results are obtained with enemata and the insertion of high rectal tubes. In postoperative peritonitis the abdomen is not distended as early as in ileus, but it is uniformly rigid and tender and the pulse becomes more rapid from hour to hour. Enemata and the high rectal tube also yield negative results, as in ileus. In both ileus and peritonitis the vomiting is never in as large quantity nor so brown and sour as in acute dilatation and is more frequently repeated, gradually becoming stercoraceous.

POSTOPERATIVE ILEUS.

This subject has attracted considerable attention, and various divisions have been suggested. The one hitherto accepted by the majority of surgeons has been that of Mikulicz into:

(*a*) Mechanical.

(*b*) Dynamic.

Finney[1] has recently suggested what seems to be a better classification; his division is as follows:

(*a*) Mechanical.

(*b*) Septic.

(*c*) Dynamic.

While the distinction is very often impossible, the diagnostic features are generally as follows:

Mechanical ileus is characterized by later onset, visible peristalsis, and severe colicky abdominal pains. The abdominal distention is asymmetrical, and at first there is no change in the pulse or temperature. Later the condition is characterized by persistent vomiting and constipation.

Septic ileus is often masked by the general signs of septicemia, thus differing in its clinical aspect from that of mechanical ileus.

A dynamic ileus develops as the result of a paralysis of the intestinal muscles, with few of the signs of obstruction and none of the signs of septicemia. The difficulty of differentiating an acute ileus from an acute peritonitis is apparent, and the later the case is seen, the more difficult does this differentiation become, for advanced cases of obstruction are almost always complicated by peritonitis. In both conditions the leukocytes are increased, and in both the opsonic content of the blood is very high. In favor of the diagnosis of obstruction are a rapid, feeble pulse; ashy, pinched countenance; rapid distention of the abdomen, which is not board-like; increased peristalsis; early and severe vomiting, soon becoming fecal; severe, cramp-like pain referred to the umbilical region, and absence of fever.

In some cases of postoperative obstruction no symptoms appear until weeks or months after the operation. The symptoms are usually due to bands or adhesions. The diagnosis in these cases presents no difficulty. The symptoms of obstruction appear in a patient who has previously been subjected to an abdominal operation.

There are other cases in which adhesions following an operation result in incomplete obstruction. In this class, especially frequent after appendiceal operations, the patients present a variety of symptoms. The patient may complain simply of colicky pains, accompanied by more or less abdominal distention and constipation. In other cases there is the history of colicky pains, accompanied by nausea and vomiting, recurring at irregular intervals. A form of postoperative ileus of the mechanical type, to be especially mentioned, is strangulation of a loop of intestine in a postoperative hernial opening. This may occur months or years subsequent to an operation.

[1] "Annals of Surgery," June, 1906.

Gastromesenteric Ileus.—A number of cases have been described by Finney, Coolman, Albrecht and others of a postoperative complication which has been called gastromesenteric ileus. Undoubtedly many cases of so-called acute dilatation of the stomach are in reality cases of gastromesenteric ileus, but these two conditions cannot be differentiated clinically. In gastromesenteric ileus there is obstruction to the lumen of the duodenum by the root of the mesentery and its contained superior mesenteric vessels. Whether this duodenal dilatation is primary or secondary to the gastric dilatation has not been determined.

POSTOPERATIVE PERITONITIS.

The occurrence of peritonitis as a postoperative complication is comparatively infrequent at the present time. The symptoms and diagnosis do not differ in any respect from those occurring in peritonitis complicating disease or injury of any of the abdominal viscera, that is, not following operation (see page 258).

The chief diagnostic points are the same as those following perforation of a viscus, etc., as given on page 262: (*a*) Colicky pains, gradually increasing in severity; (*b*) uniform muscular rigidity, and tenderness on pressure over the abdomen; (*c*) rapidly increasing distention; (*d*) gradually rising pulse-rate, reaching 140 to 160, or even higher at the end of twenty-four hours; (*e*) absolute constipation, regardless of cathartics or enemas; (*f*) sunken eyes; anxious expression, subnormal temperature, general cyanosis, cold and clammy extremities, dry, coated tongue, diminished secretion of urine, vomiting and hiccough, often persistent.

The symptoms which should attract the most attention are the rapidly increasing pulse-rate, the condition of the abdomen, and the complete obstipation, neither feces nor flatus being passed, even with the aid of the high rectal tube or high enemata.

RENAL COMPLICATIONS.

Both ether and chloroform have an irritant effect upon the normal kidneys. A large number of observers have found that in about 25 per cent. of all cases the administration of either of these anesthetics is followed by the appearance of albumin and of hyaline and granular casts in the urine. This condiiton of renal irritation lasts only from one to four days, as a rule, and does not give rise to any postoperative symptoms.

Cases, however, have been reported by Fränkel and others wh[illegible]

prolonged (two to three hours) administration of chloroform has been followed in eight to ten days by death. In such cases the chloroform caused marked fatty degeneration of the heart muscle, as well as of the hepatic and renal parenchyma.

It has also been found[1] that during the administration of ether to animals, the excretion of nitrogenous substances is practically abolished.

The question which is of direct interest in respect to postoperative renal complications is, Do ether and chloroform have any ill effects upon the diseased kidney? There is some difference of opinion in regard to this question. There are some surgeons who believe that it is perfectly safe to give ether to nephritic patients. The majority, however, believe that the administration of nitrous oxid gas or of chloroform is not followed by renal complications in those previously suffering from such disease. Ether may, on the other hand, be given to a large percentage of patients suffering from nephritis of the more chronic type and not be followed by any mild or graver signs of irritation.

In a certain percentage of cases there is indisputable clinical evidence that various forms of renal complications may occur after operation. This often takes place when least expected.

The various clinical forms of such complications are:

1. Mild uremic symptoms, such as (*a*) nausea and vomiting (prolonged many days after this common postoperative symptom should have ceased); (*b*) headache; (*c*) diminished quantity of urine, containing variable amounts of albumin and casts, and decrease in urea percentage.

2. Grave uremic symptoms—such as convulsions, restlessness, delirium, and coma. The secretion of urine may be practically abolished or it may contain the various constituents so characteristic of uremia under non-operative conditions. These may be blood, hyaline, granular, and epithelial casts, renal epithelium, large quantities of albumin, and a very small amount of urea.

Postoperative renal complications usually appear within twenty-four to forty-eight hours after the anesthesia. They may occur in the following classes of patients:

1. As an acute exacerbation of a latent nephritis, which had not been recognized before operation.

2. As an acute nephritis developing in a patient who had been previously known to have a chronic nephritis, either latent or active.

3. As a reflex anuria of one kidney (see page 428), following operations upon the opposite, especially nephrectomy or nephrotomy.

[1] "British Medical Journal," Sept. 9, 1905.

The diagnosis in all of these classes of cases can only be made: (*a*) by excluding other conditions which might give rise to postoperative nausea, vomiting, delirium, etc.; (*b*) by the previous history of the case as to urinary findings; (*c*) by the examination of the urine both quantitatively and qualitatively.

CIRCULATORY COMPLICATIONS.

Thrombosis and Embolism.—Postoperative complications, at times of the gravest character, may be the result of a thrombosis of an adjacent vein, which has occurred either prior to such operation or has developed subsequently to it. In the former condition we speak of a preoperative and in the latter of a postoperative thrombosis. If the phlebitis is of a non-suppurative type, the condition may give rise to local signs, such as pain and swelling, or it may cause any of the forms of embolic pulmonary complications spoken of on page 795, viz., infarcts, pneumonia, embolism, and pleuritis. If the phlebitis is of the septic or suppurative type the clinical picture is more like that of a septicopyemia with the formation of metastatic foci of septic infarction or embolism.

The non-suppurative type of postoperative thrombosis is comparatively frequent. Cordier[1] in a recent paper states that it occurs in about 2 per cent. of all abdominal operations. It is most common after appendectomy, herniotomy, salpingectomy, oöphorectomy, and hysterectomy. It occurs even when the primary condition has been an aseptic one. Gangrene of the affected limb has never occurred. In the majority of cases either the right or left femoral or saphenous veins are affected or the veins of both sides.

In a number of cases the mesenteric or pelvic veins or those of the abdominal wall are affected.

Clinically these cases of phlebitis appear in one of two forms:

1. A variable time after operation, usually from the seventh to the fourteenth day, the patient may suddenly show the signs of pulmonary embolism described on page 795, viz., dyspnea, cyanosis, rapid pulse, etc. These are the cases in which either a diagnosis of phlebitis was not made, on account of the depth of the vein involved, or the clinical picture of a phlebitis was not recognized.

2. The phlebitis, with the resultant thrombosis, appears about the tenth to fourteenth day. It causes pain referred to the saphenous or other veins involved. Accompanying the pain there is tenderness

[1] "Jour. Amer. Med. Assoc.," 1905, p. 1792.

over the course of the vein, and the latter can be felt (if the saphenous is involved) as a firm, tender cord.

If the femorals are involved, there is usually quite marked swelling of the entire limb, the edema being of a firm character, and the skin glossy and pale (formerly termed phlegmasia alba dolens). At times, all of the superficial veins are quite prominent and thrombosed.

The diagnosis in these cases of postoperative thrombosis is usually not difficult, if veins like the saphenous or femoral are involved. In the other veins a diagnosis before the occurrence of embolic symptoms is impossible.

MISCELLANEOUS POSTOPERATIVE COMPLICATIONS.

Postoperative Eruptions.—(*a*) *Surgical Scarlatina.*—This subject has been thoroughly reviewed by Dr. Alice Hamilton.[1] It may occur after almost any operation, in both adults and children. It does not differ clinically from ordinary scarlatina except in the following particulars:

1. It is especially apt to attack adults.
2. The period of incubation is shorter than that of ordinary scarlatina.
3. The eruption begins at the wound or in some other unusual place.
4. The throat symptoms are either mild or absent.
5. Desquamation occurs at an earlier period.

In the majority of cases reported in the literature as surgical scarlatina, the eruption was either due to sepsis or to erysipelas. The latter is especially apt to be puzzling to differentiate, if it begins in the throat as an angina.

(*b*) *Septic Rashes.*—This greatly resembles a surgical scarlatina, but can be differentiated from it by the accompanying symptoms of septicemia. The eruption is usually a diffuse erythema, is accompanied by a marked rise in temperature, rapid pulse, restlessness, etc. It usually lasts only a few days. In children it appears even in mild cases of sepsis, and frequently the eruption is the only symptom present. There are usually no changes in the wound even in the graver cases. In these cases the symptoms of septicemia (page 615) accompany the eruption.

The following are some of the points which may help in distinguishing a septic from a scarlet fever rash:

[1] "American Journal of Med. Sciences," 1904.

1. The premonitory febrile symptoms are usually absent, the rash being the first thing noticed in most cases.

2. The distribution of the rash is irregular; it appears often simultaneously all over the body, and not, as in scarlet fever, on the neck and face first.

3. There are no throat symptoms, except in those cases where the wound is in the throat.

4. The pyrexia is high and of the septic type, with often marked intermissions.

(*c*) *Drug Eruptions and Poisoning.*—These may either be local, as the result of the action on the skin of the field of operation, or there may be more generalized eruption. They are frequent after the use of bichlorid of mercury, carbolic or salicylic acids, or any preparation containing iodin.

The localized eruption is either a fine pustular one, or there are all the signs of an acute dermatitis. The more generalized eruptions are usually of the erythematous type, often accompanied by intense pruritus.

The occurrence of postoperative symptoms of iodoform, carbolic acid, or of bichlorid poisoning are so rare at the present time that they require no special mention, being fully described in the text-books on therapeutics and materia medica.

DIABETIC COMPLICATIONS.

These are of the utmost importance, and may be of various forms.

1. A latent diabetes may be aroused into activity.

2. A previously existing diabetes may be greatly intensified and cause most serious complications. Glycosuria has been found to occur in normal individuals after operations. The sugar is, however, transitory and is so slight in amount as to have no clinical significance. The usual forms in which postoperative diabetic complications appear, are (*a*) as a gangrene of the edges of the wound or of a limb with early evidences of marked sepsis; (*b*) as a coma accompanied by pulmonary edema and resulting fatally within a few days after the operation; (*c*) as a marked glycosuria, which gradually subsides without giving rise to any general symptoms.

The development of these diabetic complications must always be borne in mind, not only in those whose urine was known to contain a trace or a larger quantity of sugar before the operation, but in every patient above middle age. *A preoperative urinary examination must*

always include the test for sugar. The diagnosis of a diabetic coma must be made by excluding other causes for the coma, such as a postoperative uremia or anuria, or gangrene, and by finding sugar or diacetic acid in the urine.

POSTOPERATIVE PAROTITIS.

This occurs most frequently after abdominal operations, and is often described as a *cæliac parotitis.* It may also appear as a complication of inflammatory affections of the abdominal viscera.

The parotid gland of one or both sides is almost invariably involved. The inflammation may be (*a*) of a simple type, like that occurring in the epidemic form of parotitis (mumps); (*b*) abscess formation may take place; (*c*) gangrene of the parenchyma may occur. The diagnosis is not difficult. The appearance after an abdominal operation of a swelling, just in front of and below the ear, accompanied by tenderness and fever, is quite characteristic. If suppuration or gangrene occur, the local signs are correspondingly more marked.

STATUS THYMICUS.

This peculiar complication of anesthesia has been recognized for some time. After the administration of chloroform, death has suddenly occurred, accompanied by symptoms of cardiac and respiratory paralysis. In the autopsies on these cases, usually children, a general hyperplasia of the lymphatic structures has been found. The thymus gland is markedly enlarged and from this finding the condition first received its name.

ACUTE THYROIDISM.

This is a complication occurring after thyroidectomy. The symptoms are a great rise in temperature (103° to 108° F.), high pulse-rate, face flushed, restlessness, and at times delirium and coma.

The condition may be only a transitory one, or it may result fatally.

POSTOPERATIVE HYSTERIA.

This requires no special description. The diagnosis of the various forms, in which this protean affection may appear, does not differ in any manner from the recognition of hysteria occurring under other circumstances than as a postoperative condition.

CHAPTER VIII.

METHODS OF EXAMINATION.

BLOOD EXAMINATION AS AN AID TO SURGICAL DIAGNOSIS.[1]

The methods most frequently employed are: (1) Counting the red blood-cells and observing their shape, size, coloring, etc. (2) Estimating the percentage of hemoglobin and determining the color index. (3) Counting the leukocytes and the differential leukocyte-count. (4) Determining the specific gravity of the blood and its freezing-point (cryoscopy). (5) Search for parasites in the blood (malaria). Blood cultures in septicemia, etc. (6) Determination of the coagulation time of the blood. (7) The agglutination reactions, *e. g.*, typhoid. (8) Special cell reactions, *e. g.*, iodophilia. (9) Determination of the opsonic index.

The technic of all of the above methods is purposely omitted in this chapter, owing to the fact that it is so fully described in the various books upon the subject of clinical diagnosis.

1 and 2. The number of red cells in a cubic millimeter of the blood, their shape, coloring, etc., and the percentage of hemoglobin should always be determined in cases where there is apparent anemia or in infections of the subacute or chronic type. The actual physical condition of the patient can be better estimated and an obscure internal hemorrhage may be diagnosed before changes are observed in the peripheral vessels. An unsuspected pernicious anemia may be discovered by its typical blood findings. With the progressive lowering of the percentage of hemoglobin, operative procedures become more hazardous.

If the patient's percentage of hemoglobin is below fifty, the question of whether or not an operation shall be performed must be carefully considered. In such individuals the processes of healing are very much slower than normal, the coagulation time is greatly delayed, and the risk of postoperative shock is great.

3. The **leukocyte-count** in surgical cases is very important, and one should make such a count wherever possible. The normal average, as generally accepted, is 7500 leukocytes per cubic millimeter of the blood.

A) *Increase, or Leukocytosis.*—This may occur physiologically in blood concentration and peripheral stasis. A physiologic increase also

[1] The section upon blood examination was written by Dr. D. L. Schram, of Chicago.

occurs during digestion and pregnancy. Mechanical and thermal influences will also increase the count. All of these conditions must be considered in estimating the value of a leukocyte-count.

Pathologic leukocytosis: This occurs, first, in inflammations and infections; second, in serious and hemorrhagic exudates; third, in intoxications; fourth, in malignant tumors; fifth, in certain parasitic diseases such as trichinosis.

The cause of leukocytosis is the activity of the bone-marrow and the other blood-forming organs, in their effort to protect the organism against a noxious invader. It is purely defensive, and, in general, it may be said that the degree of leukocytosis is in direct proportion to the activity of the cells of the body and the invading infection.

Degree of Leukocytosis.	Intensity of Irritant.	Resisting Power.
1..... Marked.	Marked.	Normal.
2..... Slight.	Moderate.	Normal.
3..... Slight.	Slight.	Slightly below normal.
4..... Absent.	Marked.	Feeble.
5..... Absent.	Feeble.	Normal.

(*B*) *Leukopenia.*—This means a diminished number of white blood-cells and is of diagnostic value because it occurs in the following conditions:

(*a*) In starvation and malnutrition. In these, it is usually associated with an increase of lymphocytes. Cancer of the esophagus is the most important condition here.

(*b*) Short but extreme variations of temperature, both heat and cold.

(*c*) Infectious diseases, such as typhoid, influenza, measles, and closed tuberculous lesions.

(*d*) Blood diseases, such as pernicious and splenic anemia. Any severe anemia may cause such a change.

(*e*) Drugs, such as ergot, tannic acid, sulfonal, atropin, and agaracin.

(*C*) *Hyperleukocytosis.*—This is a relative term, because there is no sharp line between an extremely high degree of leukocytosis (200,000) and a true leukemia. A very high count, however, must be either considered as a good reaction in a severe infection (see infectious leukocytosis on page 817).

(*D*) *Differential Leukocyte-count.*—Attention has been recently called by Gibson[1] to the value of the differential leukocyte-count in surgical cases, especially those due to infection. Normally the percentage of each variety of leukocyte, as given by Cabot,[2] in the blood of healthy adults is:

[1] "Annals of Surgery," April, 1906. [2] Cabot: "Clinical [redacted] of Blood."

(*a*)	Small lymphocytes	20	to 30 per cent.
	Large lymphocytes	4	to 8 "
(*b*)	Polynuclear neutrophiles	62	to 70 "
(*c*)	Polynuclear eosinophiles	0.5	to 4 "
(*d*)	Polynuclear basophiles	0.25	to 2 "

Sahli estimates the number of polynuclear neutrophiles at 70 to 72 per cent. Sondern's average for polynuclear neutrophiles in the normal blood is 68 per cent. Gibson has adopted 75 per cent. as a working average.

The method of estimating the different kinds of leukocytes is readily accomplished by staining a film of dried blood by the Ehrlich, Wright,[1] or Zollikoffer[2] stains. The application of this differential leukocyte-count to surgical diagnosis will be referred to on page 823.

4. **Specific Gravity of the Blood.**—The specific gravity of the blood has little significance except in its relation to the degree of blood concentration and hemoglobin content.

Determination of the freezing-point of the blood, or cryoscopy, is of considerable service in determining the functional capacity of the kidneys (see page 835).

5. **Parasites in the Blood.**—(*a*) The first and most important of these is the plasmodium of malaria. One must always keep this in mind, and the parasite should be carefully sought after in intermittent fevers and obscure temperatures, especially if the spleen is enlarged. (See technic in works on hematology.) (*b*) Parasites of filariasis, relapsing fever, Rocky Mountain fever, trypanosomiasis, should be considered. (*c*) Blood cultures in pyemias and septicemias of all varieties should be made and the variety of infecting organism should be determined as an indication for prognosis and treatment. (See works on bacteriology.)

6. **Coagulation Time of the Blood.**—It is important to study the rapidity of the blood coagulation outside the body, despite the fact that it presents many differences from coagulation within the body. The time of coagulation depends upon temperature, the nature of the receiving vessel, whether rough or smooth, whether the blood comes from a deep incision or a superficial cut, and the length of time the drop is allowed to remain in contact with the wound. The coagulation time will vary according as the blood is forced out or allowed to well up. The last drops from a wound clot more quickly than the first drops. The time of coagulation is shorter in the morning than later in the day. Foods affect the coagulation also, so tests should not be made directly after taking

[1] Cabot: "Clinical Examination of Blood."

[2] Sahli: "Diagnostic Methods."

nourishment. The main point, then, is to develop a uniform technic, and always use the same one.

The crudest test is to allow the blood to drop on a glass slide and test coagulation with a needle-point. A method of considerable accuracy, but requiring a microscope, is that with the apparatus of Russel and Brodie modified by Boggs.[1]

In surgery the knowledge of the time of coagulation of the blood is very important in operative work. The average coagulation time is two to eight minutes.

In hemophilia the time may be delayed to one hour; in purpuric conditions and secondary or symptomatic hemophilia, to thirty minutes or more. In dropsical conditions it is especially important, as the time here is very much delayed. Other conditions are jaundice and alcoholism, cirrhosis of the liver, and many anemias. The time is usually shortened in inflammatory conditions and infections generally where there is a leukocytosis.

7. **Agglutination Reactions.**—Under this heading special attention is called to the Widal reaction in typhoid fever. This agglutination test offers a very useful aid in cases in which a continuous temperature is present with no local findings.

8. **Special Cell Reactions** (**e. g., Iodophilia**).—If the leukocytes in acute infections are stained with the following solution: iodin, 1.0; potass. iodid, 3.0; water, 100.0; and gum arabic, 5.0—the polynuclear cells will be found to contain brownish granules. This change is not found in the normal blood, and if it be found, indicates the presence of pus even though the leukocyte count should be normal. There is no relation between the degree of suppuration and the intensity of the reaction.

9. **Opsonins and the Opsonic Index.**—The school of Metchnikoff believed that the leukocyte was the only element of the blood actively concerned in the phagocytosis of microörganisms. It attributed everything to the white blood-corpuscle, and did not consider that the blood-fluid took any active part in the phenomenon.

In the early part of 1903, Wright and Douglas, of St. Mary's Hospital, London, approached the problem of phagocytosis. They separated the corpuscular from the fluid elements of the blood. That is to say, they obtained leukocytes suspended in a neutral medium instead of in the blood-plasma, and the blood-plasma (or blood-serum) free from leukocytes or erythrocytes. They prepared also an emulsion of staphylococci in normal salt solution, and found that, if they brought together only the leukocytes and t[illegible]ylococci, practically no phagocytosis

[1] "Johns [illegible]," July, 1907.

occurred, but that the addition of blood-plasma (or blood-serum) to the leukocytes and the staphylococci effected some change, so that phagocytosis did occur. The obvious deduction was that the leukocyte by itself was impotent, and further that the blood-plasma contained some substance which was essential to the attainment of phagocytosis.

Using ingenious methods of their own, they investigated the blood-plasma in order to determine the characters of this phagocytic element, and the following are the most important of their conclusions:

1. The substance, so essential to phagocytosis, does not act upon the leukocytes (as a stimulant to the leukocytes, for example), but it combines with the microörganisms and prepares them for phagocytosis; hence the name *opsonin*, from *opsono*, I cater for, I prepare victuals for. The conception of the mode of action is that the opsonins are carried in the lymph to the nest of microbes which are responsible for the morbid process; that they chemically unite with the microörganisms, and that then, and not until then, the leukocytes have the power of enveloping and destroying these microörganisms. Thus it follows that the amount of phagocytosis which is observed is a measure of the quantity of opsonins present in any particular plasma, and does not represent the vital activity of the leukocytes.

2. The opsonins in a normal serum are almost completely destroyed by heating for ten minutes at 60° C.

3. The opsonins have been shown to be distinct from the bacteriolysins, the agglutinins, and the antitoxins.

Moreover, as shown by Bulloch and Mestern, the opsonins have a high degree of specificity. For example, the blood of a person may contain half the normal quantity of opsonins necessary to combat a tuberculous infection such as tuberculous cystitis, and yet contain a normal amount of opsonins that have to do with an invasion of staphylococci, such as causes furunculosis.

Wright and Douglas have shown by a striking experiment how invariable a factor the leukocyte really is. They obtained leukocytes both from an immunized patient and also from a normal individual. To a specimen of each of these they added some normal serum, and also some staphylococci, and allowed phagocytosis to take place. They then found that in the presence of normal serum, the leukocytes of the immunized patient took up just as many staphylococci as the normal leukocytes in the presence of the same normal serum. They next took two portions of a suspension of normal leukocytes to which had been added some staphylococci, and mixed with one of these portions some

serum from the immunized patient, and with the other some normal serum, and allowed phagocytosis to take place. They then found that the leukocytes, to which had been added the serum from the immunized patient, took up about one-half as many staphylococci as did the leukocytes to which the normal serum had been added. This affords striking testimony that the leukocyte is an indifferent or a constant factor in the phenomenon of phagocytosis. The amount of phagocytosis observed, therefore, represents the quantity of opsonins present in the blood. So far as we can tell at present, the plasma has nothing to do with the "quality" of the leukocytes.

Technic.—If we wish to measure the quantity of opsonins present in the blood of a man suffering from furunculosis, which is almost always due to the staphylococcus pyogenes, we require:

1. A drop or two of blood from the patient, and a drop or two from a normal person, from each of which we can easily obtain sufficient serum for our estimation.

2. An emulsion of staphylococci in salt solution.

3. Leukocytes washed free from their plasma.

We draw up in a capillary pipet equal quantities of the patient's serum, the staphylococcus emulsion, and the leukocytes; thoroughly mix all three, and having sealed the mixture in the capillary tube, place it in an incubator at 37° C.

With a second capillary pipet we again carry out precisely the same operations, except that instead of the patient's serum we use normal serum. This is incubated for the same length of time. An ordinary blood-film is made from each tube at the expiration of the fifteen minutes' incubation. These films are appropriately stained, and then examined microscopically with an oil-immersion lens. Numerous leukocytes are seen, in the protoplasm of which lie few or many staphylococci. The number of staphylococci, taken up by say 40 leukocytes, is counted. Let us say that in the film prepared with the patient's serum we count 80 staphylococci in the 40 leukocytes. The average per leukocyte is then $\frac{80}{40}$ or 2. This figure is known as the "phagocytic index" of the leukocyte. We then count the number of staphylococci taken up by the 40 leukocytes in the film prepared with the normal serum; let us say we count 160 staphylococci; if we divide $\frac{160}{40}$ we get the "normal phagocytic index" for this particular experiment, namely, 4.

In each of these preparations the leukocytes and the emulsion of staphylococci are constant factors; the only variable factor is the blood-serum.

The amount of phagocytosis depends upon the quantity of opsonins

present. It follows, therefore, that the comparison between the two phagocytic indices above recorded, is a comparison between the quantity of opsonins present in the blood-serum of a diseased person and in that of a normal person. The actual ratio in this case is 2 : 4 or 0.5 : 1; the

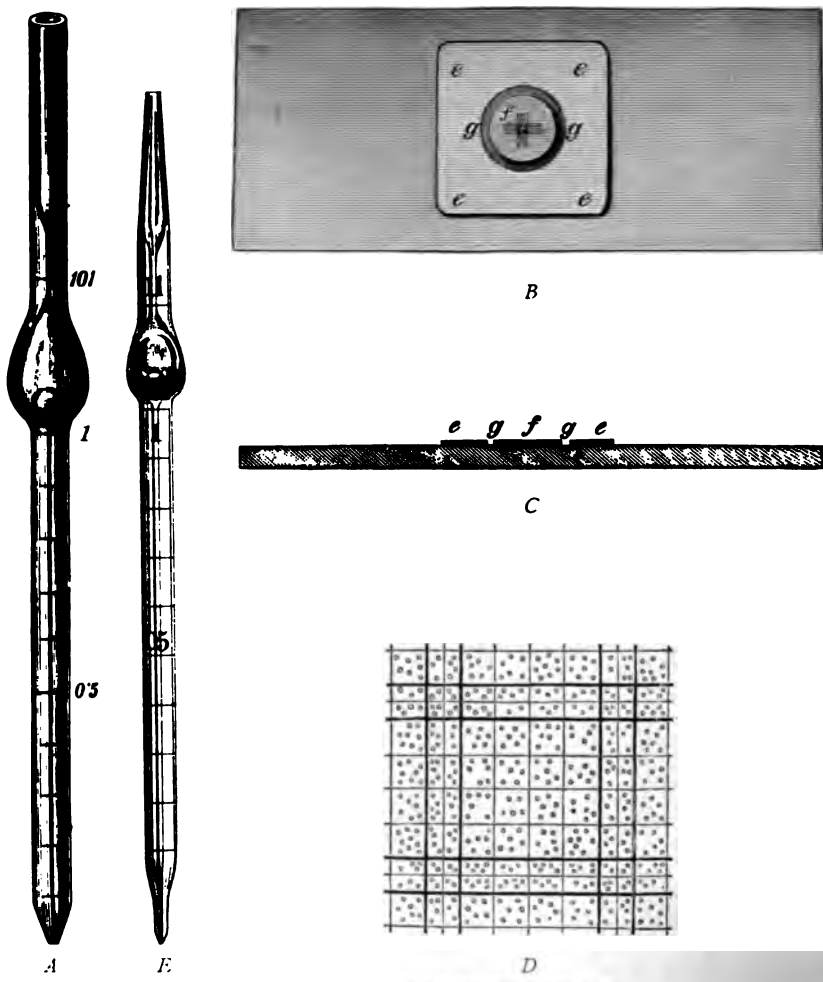


FIG. 559.—THOMA-ZEISS BLOOD-COUNTING APPARATUS.

A, Mélangeur; *B*, counting-chamber, seen from above; *C* profile of counting-chamber; *D*, microscopic picture of a portion of ruled field with blood-cells; *E*, white counter.

latter figure is the normal "opsonic index," and 0.5 is the *abnormal opsonic index* of a patient who is the subject of a staphylococcus infection, namely, furunculosis.

When we say that a patient has an opsonic index of 0.5 to staphylococcus, we mean that his blood-plasma contains but half the normal

quantity of those opsonins which are essential to combating a staphylococcal infection successfully. Moreover, it seems probable that this deficiency was antecedent to the infection or, in other words, it has made the infection possible.

Value of the Opsonic Index and Opsonic Treatment.—The practical value of the opsonic index is relatively less than its theoretical value, since many factors must be taken into consideration. The great technical difficulties and the exact identification of the particular organism, as well as the great confusion in mixed infection, have limited its use. In surgical tuberculosis it has no advantage over other methods. In pus infection, especially the subacute and chronic forms, an indication for treatment may be arrived at by careful study.

SPECIAL BLOOD DIAGNOSIS.

(A) **General Infections.**—1. *Pneumonia.*—A leukocytosis reaching as high as 50,000 to 60,000 is quite common in this disease. The leukocytosis is composed of polynuclear neutrophiles. A normal leukocyte-count with a relative increase of the polynuclear neutrophiles indicates a severe infection and reduced resistance.

2. *Typhoid Fever.*—In this condition a normal leukocytosis or even a leukopenia is the rule. This is of great aid in distinguishing typhoid from pyogenic infections. Complications which cause a rapid increase in the number of white corpuscles are as follows: intestinal perforation, cystitis, parotitis, nephritis, cholecystitis, pulmonary complications, typhoid periostitis and osteomyelitis.

3. *Diphtheria.*—A fair neutrophiliac leukocytosis is present. Myelocytes are also frequently found, but are of no diagnostic value.

4. *Scarlet Fever.*—In this condition the blood shows a leukocytosis with a high number of eosinophiles, which serves to distinguish this eruptive fever from septic rashes, etc., in which the polynuclear neutrophiles predominate and the eosinophiles are relatively low.

5. *Measles.*—A low leukocyte-count serves to distinguish this eruption from septic or drug rashes.

6. ***German Measles.***—Same as measles.

7. ***Mumps.***—A moderate leukocytosis which is increased when complications such as orchitis are present.

8. *Pertussis.*—A very high lymphocytosis is present and is quite characteristic.

9. *Vaccinia, Variola, and Varicella.*—All of these have a moderate leukocytosis.

10. *Acute [illegible] Rheumatism.*—In uncomplicated cases there is

usually a slight polynuclear neutrophilic leukocytosis (about 15,000), which persists as long as there is fever and exudation.

11. *Erysipelas.*—In this there is a very high leukocytosis of the typical septic variety, viz., a great increase in the neutrophiles. The mast cells are likely to be increased in all cutaneous eruptions, including the septic rashes like erysipelas, but this increase has no significance.

12. *Septicemia.*—This is characterized by the rapid development of severe anemia and a high degree of leukocytosis. Blood cultures may contain the causal organism.

13. *Tetanus.*—This has a moderate leukocytosis.

14. *Meningitis.*—In epidemic meningitis there is always a marked leukocytosis.

15. *Syphilis.*—Many investigators have recently tested the efficiency of the Wasserman test and find this reaction present in 90 per cent. of all cases of syphilis in whatever stage. A very simple method is given by Lee and Whittemore in the *Boston Medical and Surgical Journal*, April 1, 1909. In general, it may be said that the blood findings in syphilis are of slight value in identifying the disease, but valuable in determining the stage and condition of the patient. A low hemoglobin estimation and high lymphocyte-count early would indicate a severe infection; a high leukocytosis, that the patient is beyond the early stage; marked changes in the leukocyte varieties, as myelocytes, that the late and severe infections are present. A pernicious anemia-like picture also indicates a severe infection.

Tuberculosis.—Agglutinative reactions of Arloing and Courmont, are present in from 40 to 60 per cent., but are complicated and offer no exceptional advantages. Anemia of a secondary type is present. The leukocyte-count is normal with a tendency to lymphocytosis. An increase in the neutrophiles would indicate secondary infection. In infections of the serous membranes, especially the peritoneum and meninges, an increase in the number of leukocytes is often present.

(B) **Local Infections.**—Circumscribed suppuration usually shows a leukocytosis. Illustrations of such abscess formation are furuncles, felon, paronychia, panaritium, parotid abscess, subphrenic, neck abscesses, etc. Some of the forms of abscess formation require special mention, as follows:

Special Varieties of Abscess Formation.—*Appendicitis.*—In this condition the leukocyte-count affords valuable aid for us both as to the diagnosis of the condition, as well as to the stage of the pathologic process. The count should be made at regular intervals, say every hour or two, in all cases, and compared with the symptoms and general condition of the patient.

The following are general conclusions from actual cases, according to Cabot:

1. There are no changes in the red cells, except the anemia of chronic cases.

2. Coagulation slow, but the fibrin is always increased in pus cases.

3. As in all infections, the very mild and very septic cases show no leukocytosis.

4. Catarrhal appendicitis is rarely accompanied by leukocytosis. An increase from 12,000 to 14,000 is a rare exception.

5. An increasing leukocytosis is an evidence of a spreading process. It should be closely watched and never disregarded. This is of far more significance than the actual number of cells.

6. A low count, 8,000 to 11,000, means one of several things:

(*a*) A mild case.

(*b*) A very severe case in which the resistance of the organism is diminished.

(*c*) An abscess thoroughly walled off.

After the abscess has become walled off the count usually remains stationary or slightly decreases. If the count rapidly increases after such a condition, it means that the abscess has ruptured into the peritoneal cavity. Such a rupture may not, however, be accompanied by an increase, but sometimes by a rapid fall of the leukocyte-count.

7. In the majority of cases the abscess is not completely walled off, and a moderately fluctuating leukocytosis is found.

When the leukocytosis increases slowly and steadily, the case is increasing in severity, as a rule.

When a leukocytosis of 18,000 to 25,000 is maintained, it means a localized large abscess.

8. Size of leukocytosis:

(*a*) Catarrhal, usually below 12,000.

(*b*) Acute diffuse appendicitis without pus, 11,000 to 22,000.

(*c*) Gangrenous appendicitis, usually 20,000 or more.

(*d*) When pus distends the appendix the count is high, 20,000 or over.

When an acute perforation occurs into the free peritoneal cavity, the leukocytosis may fall temporarily; if a reaction on the part of the body takes place, a rapid increase follows; if no reaction takes place, there is no increase.

Differential Diagnosis.—The leukocytosis of appendicitis will differentiate the following conditions:

(*a*) Intestinal colic and the crises of locomotor ataxia.

(*b*) Impaction of feces.

(*c*) Gallstone colic and renal colic, if no infection is present.

(*d*) Ovarian and pelvic neuralgic pains.

(*e*) Floating kidney.

(*f*) Extrauterine pregnancy—this does cause a leukocytosis at times, however.

Acute and Chronic Salpingitis and Pelvic Peritonitis.—These cause the same changes as found in appendicitis, and the blood-count is of value only in distinguishing them from non-septic conditions.

Infection of the Gallbladder and Bile-passages.—Exactly the same may be said of these as of pelvic infection and appendicitis. The blood is only of value to establish the fact of infection and pus formation, but is of little value in differentiating it from other abscesses.

Osteomyelitis has a high leukocytosis which is extremely valuable in differentiating it at an early stage from rheumatism or the prodromes of infective disease, especially smallpox.

Infections of the Serous Membranes.—*Pleural, Pericardial, and Peritoneal.*—This is almost always accompanied by a leukocytosis. The degree of leukocyte increase is extremely variable, and varies from normal to 40,000, and even higher. It is not always possible to differentiate the serous and dry inflammations from the suppurative, as the latter may not have a higher leukocytosis than other varieties.

The leukocyte count is, however, valuable in the following conditions:

(*a*) To differentiate peritonitis from (1) obstruction (non-malignant), (2) malignant disease, (3) hysteria, malingering, etc. A leukocytosis speaks in favor of an inflammatory process.

(*b*) From tuberculous infection, which has no leukocytosis.

Gastro-intestinal Tract.[1]—*Gastric ulcer* causes an increasing anemia with a moderate leukocytosis. Of diagnostic value excepting in complications.

(*a*) Perforation, a rapid rise in the leukocyte-count is usual.

(*b*) Hemorrhage, often an increase of leukocytosis. In chronic hemorrhagic cases the picture may simulate a pernicious anemia.

Duodenal Ulcer.—Same as in ulcer of stomach proper.

Acute Gastro-intestinal Affections.—A fairly well-marked leukocytosis is the rule.

Chronic Digestive Disturbances.—As a rule, no leukocytosis and no digestion leukocytosis.

[1] Visceroptosis has no effect upon the blood itself, but may cause toxemias, etc., which produce blood changes.

Intestinal Obstruction.—According to Bloodgood, the leukocyte-count here is valuable. Within a few hours the leukocytes rise rapidly. If obstruction is partial, the counts are between 14,000 and 16,000; if complete, usually 20,000 or more. The higher the count and the shorter the duration, the greater the probability of gangrene. If the count shows 20,000 within the first twenty-four hours, the chances are that gangrene is present. On the second day the count does not change much. Then if gangrene or peritonitis occurs the count begins to fall; otherwise the count remains high until the fourth or fifth day, when the leukocytes gradually fall, whatever the condition of the abdomen. If after three days of obstruction the count is still over 20,000 the prognosis is good. If the count is below 15,000 the probability is that gangrene, peritonitis, or fatal auto-intoxication has occurred.

Surgical Conditions of the Liver.—The coagulation time of the blood is reduced in all conditions affecting the function of the liver. This is especially true if jaundice is present, when the hemorrhage from an operative procedure may be uncontrollable. Usually the capillary vessels are the worst ones.

Gallstones, when no infection is present, cause little or no change. A slight leukocytosis is sometimes found. During a colic this may be slightly increased, but, as a rule, not to be compared with the leukocytosis of infectious processes. All infectious processes of the liver and bile-passages cause a marked leukocytosis; for example, cholangitis, cholecystitis, abscess, thrombosis, and infections of the blood-vessels. This is valuable in differentiating them from typhoid, grippe, etc., which may simulate these conditions.

Diseases of the Pancreas.—Acute pancreatitis and hemorrhagic pancreatitis show a fair increase in the leukocyte-count, which will help to distinguish them from the ordinary pains of indigestion, etc. Chronic pancreatitis shows no such change, a low percentage of hemoglobin being the only help in a diagnostic way that may be present.

Urinary System.—Infections cause a leukocytosis. This is the only distinguishing feature, and aids in determining, for instance, when pus is present in calculous obstruction, and helps fix indications for an operation.

The same holds true in all kidney and bladder affections. The determination of the functional capacity of the kidneys by means of the phloridzin and indigo-carmin tests, and by determining the freezing-point of the blood, will be described elsewhere (see page 852).

Nervous System.—The blood examination is of little value in

diagnosing diseases of the nervous system directly, as few characteristic conditions are produced.

Injuries, infections, and all suppurations increase the number of leukocytes, so that they help to establish the presence of an obscure abscess, for instance, or differentiate it from a tumor. The leukocyte-count is of value in detecting malingering and hysteria in many cases.

Malignant Disease.—Blood examinations in malignant tumors sometimes afford substantial aid in locating and determining the rapidity of growth and the degree of malignancy, the presence of ulceration and secondary infection, as well as of repeated internal hemorrhages, when carefully considered together with the symptoms.

The blood as a whole shows the picture of a secondary anemia, that is, the reduction in the hemoglobin, and the blood-cells are in about the same proportion.

Occasionally the blood-destroying power or malignancy of the tumor is so great that the picture of a pernicious anemia is produced.

In most cases the coagulation time is normal or increased. When sloughing is present, it becomes more rapid. When an inflammatory reaction occurs around the tumor, the fibrin may be greatly increased. The red cells are usually smaller in size, pale, and are easily destroyed.

The hemoglobin in cancer cases will average 50 per cent. or lower.

The color index is almost invariably below 1.

The leukocyte changes in cancer are important and depend on the following conditions:

I. On the position of the growth.

(*a*) When the tumor is situated in the esophagus or cardia, the leukocytes may be diminished. It is in this situation that the pernicious type of anemia is frequent. When the leukocytes are increased, it is fair to assume the presence of these growths in other locations, or that extensive sloughing is taking place.

(*b*) Cancer of the uterus and of the stomach, especially if hemorrhages are taking place, show a high leukocyte-count.

(*c*) Malignant tumors of the kidney, thyroid, and pancreas almost always cause a high leukocytosis.

II. Size. Everything else being equal, tumors of the parenchymatous organs and viscera cause greater leukocytosis than the slower growing epitheliomatous and scirrhus varieties. For example, cancers of the skin, lip, scirrhus of the breast, etc., cause a low leukocyte-count, while tumors of the liver and kidney produce very large ones, as these tumors, as a rule, grow to be of large size.

III. Cancer of the bones and blood-forming organs may give a

blood-picture depending on the blood-function of these organs. For instance, large numbers of myelocytes, eosinophiles, and intermediate cells may be present, in some respects simulating leukemia, so offering valuable aid in locating metastasis in bones, etc.

Sarcoma.—The blood in this condition is of about the same importance as in carcinoma, with the exception that the changes, as a rule, are greater.

IV. *Anemias.*—Primary anemias, as chlorosis, pernicious anemia, and the typical blood diseases, leukemia, Hodgkin's disease, and splenic anemia, have positive diagnostic changes, the value of which is self-evident in all surgical cases, a description of which can be found in any work on hematology.

The secondary anemias are of great surgical importance and occur under widely different conditions. They are characterized by a decrease in both red and white cells; the hemoglobin, however, is less in percentage than the red cells; that is, there is a color-index of less than 1. The leukocytes may be increased or decreased in number, depending upon the cause.

THE VALUE OF THE DIFFERENTIAL LEUKOCYTE-COUNT.

The paper of Gibson[1] previously referred to (page 811) is a valuable contribution to the value of this diagnostic method. Every surgeon who has had occasion to try this method since the publication of the article of Gibson agrees with the latter that the real value of the polynuclear count lies in "*the relative disproportion of the polynuclear percentage to the total leukocytosis.*" Gibson believes that "with a moderate rise of the total leukocytosis there should be, in favorable cases, a moderate rise of the polynuclear cells only, showing that the infection is localized and absorption is limited. On the other hand, if there is only a moderate leukocytosis with a notable increase in the polynuclear cells, it indicates almost unquestionably that there is either a severer form of lesion or less resistance to absorption, or that both conditions exist." His conclusions will be quoted in full.[2]

The differential leukocyte-count is of value chiefly in indicating fairly consistently (1) the existence of suppuration or gangrene, as evidenced by an increase of the polynuclear cells disproportionately high as compared to the total leukocytosis.

(2) The greater the disproportion, the surer are the findings, and

[1] "Annals of Surgery," April, 1906.

[2] For further details, the reader is referred to the original article.

in extreme disproportions the method has proved itself practically infallible.

(3) As the relative disproportion between the leukocytosis and the percentage of polynuclear cells is of so much more value than the findings based on a leukocyte-count alone, this latter method should be abandoned in favor of the newer and more reliable procedure.

(4) The negative findings, showing no relative increase or even an actual decrease of the proportion of the polynuclear cells, while of less value, shows with rare exceptions the absence of the severer forms of inflammation.

(5) In its practical applications, the method is of more frequent value in the interpretation of the severity of the lesions of appendicitis and their sequela.

Value of the Ordinary Leukocyte-count in Differential Diagnosis.—I. When we are dealing with an obscure, deep-seated disease when hemorrhage can be excluded, the presence of a persistent leukocytosis suggests suppuration or malignant disease, rather than tuberculosis or syphilis, for example, and excludes any simple functional or hysterical affection. The absence of leukocytosis, however, does not exclude malignant disease, though it makes suppuration very unlikely.

II. Between malignant disease and suppuration, if the other signs and symptoms do not decide, there may be nothing in the blood to decide. In decided pyemia we may get pyogenic cocci in the blood by culture, but a negative result would not exclude a suppurating focus. The reaction of iodophilia may help to decide the presence of pus, also the increase of fibrin in the blood speaks for the presence of pus.

III. Between malignant disease and hemorrhage, a marked anemia favors hemorrhage, as the anemia of cancer is slow to develop. The leukocytes give no special aid.

IV. Between cancer and ulcer of the stomach, if there has been no recent hemorrhage, leukocytosis favors cancer, but its absence is of no weight either way. In cancer the hemoglobin steadily decreases, while in ulcer it fluctuates—increasing between hemorrhages, and dropping immediately after one.

The presence of a digestion leukocytosis speaks for ulcer, but if any degree of catarrh and glandular degeneration is present it would also be absent in ulcer.

V. Between cancer of the liver and bile-ducts, on the one hand, and simple gallstone colic or obstruction, on the other, the presence of a leukocytosis favors cancer, and we must bear in mind that gallstones

with cholangitis may raise the leukocyte-count as much or more than in cancer. Simple cysts or echinococcus cysts cause no leukocytosis, nor does syphilis of the liver.

VI. The appearance in the blood of large numbers of eosinophiles, myelocytes, and nucleated rods will arouse the suspicion of metastasis in the bones.

VII. If the leukocytosis disappears with the removal of the growth and then reappears, we may look for recurrence of the growth.

VIII. A steadily increasing leukocytosis in a case of malignant disease points to a rapidly growing tumor or the occurrence of metastasis.

IX. Between malignant disease and pernicious anemia, the diagnosis will rest on the following points:

	Malignant Disease.	Pernicious Anemia.
Color index and volume index	Low—less than 1.	Usually above 1.
Leukocytosis	Usually increased.	Diminished.
Lymphocytes	Relatively decreased.	Increase in active number.
Average size of red cell	Usually below normal, 7.5.	Often increased, and great variation in size.
Nucleated red cells	If present, the normoblast type predominates.	Normoblasts the minority—megaloblasts frequent.

X. Between a malignant and a benign tumor, the presence of a leukocytosis will speak against its being benign.

XI. When we suspect a tumor and no actual increase in the whole count is present, the increase of the polymorphonuclear variety will have the same significance as a leukocytosis.

Tuberculosis in a general way may be stated to cause a gradual loss of hemoglobin and red cells, producing the typical secondary anemia. The leukocytes are usually not increased when secondary infection is absent, and this is valuable in diagnoses.

There are many exceptions to this rule, however, such as:

Meningeal tuberculosis—leukocytosis 7,000 to 30,000.

Bone tuberculosis—often a slight increase.

Genital tuberculosis—a leukocytosis is rather the rule.

Syphilis.—The blood-findings offer little information to the surgeon for diagnostic purposes—except possibly the fact that the increasing lymphocytosis would indicate a late stage and its non-contagious stage.

THE ESTIMATION OF BLOOD-PRESSURE IN SURGICAL CASES.

Blood-pressure.—The determination of blood-pressure has assumed such practical importance that every surgeon should be familiar with the use of the appropriate instruments.

Of the latter there are a number of different kinds. The one which is most easily employed at the bedside or operating table is the Riva-Rocci sphygmomanometer, as modified by Cook and Briggs (see Fig. 16). For details as to its use, the reader is referred to special treatises on the subject of blood-pressure. Experimental and clinical observations by Crile, Cushing, Cook, Janeway,[1] and others have shown that the estimation of blood-pressure is of great value from both a diagnostic and therapeutic standpoint in the following surgical conditions:

During Surgical Operations.—To be of value a determination should be made every five minutes, the pulse-rate being recorded on a chart. Ether, even in large amounts, seldom produces a significant fall in blood-pressure. Chloroform is usually accompanied by a marked fall in blood-pressure in 69 per cent., and a moderate fall in 18.9 per cent. of the cases, according to Blauel.

An initial rise in blood-pressure follows any cutting operation, while the irritation of large nerve-trunks causes a much greater reflex rise of blood-pressure.

The opening of the peritoneal cavity is at first followed by a sharp rise, but there is a subsequent fall in blood-pressure dependent on the duration of the operation and the amount of exposure and manipulation of the viscera.

Blood-pressure in Surgical Accidents and Diseases.—Hemorrhage.—The loss of any considerable volume of blood, either during an operation or as the result of an accident, causes an immediate fall in blood-pressure. It is very difficult to draw any deductions after an accident as to whether the low amount of blood-pressure is the result of hemorrhage or shock. This uncertainty is due to the fact that the acute anemia causes a considerable degree of shock. One distinction is, however, present, viz., that if the bleeding is checked or ceases spontaneously, and is not succeeded by shock, the blood-pressure will gradually rise. This latter condition is due to the fact that there is a definite physiologic tendency for the blood-pressure to return to its level.

Collapse and Shock.—The term *shock*, according to Crile,[2] should

[1] Janeway: "Clinical Study of Blood-pressure." Cook: "Jour. Amer. Med. Assoc.," p. 1199, 1903.

[2] "Boston Medical and Surgical Jour.," March 5, 1903.

be limited to the condition (page 792) in which there is a gradual fall in blood-pressure. The term *collapse* should be confined to those cases in which the essential phenomenon is a sudden fall of blood-pressure, due to hemorrhages, injuries of the vasomotor center, or cardiac failure. The lowering of the blood-pressure in shock is due to repeated afferent impulses acting on the vasomotor center and causing exhaustion of the latter.

In operations involving handling or long exposure of abdominal viscera, after subcutaneous injuries of the thoracic or abdominal viscera, or in peripheral injuries such as follow a crushing force, there is a steady fall in blood-pressure as a symptom of shock.

Head Injuries.—The marked rise in blood-pressure, as an expression of increased intracranial tension in head injuries or diseases, has been referred to (page 41).

The estimation of the blood-pressure is of considerable value in connection with all other general and focal symptoms.

A low blood-pressure, according to Kocher[1] and Cushing,[2] may be present in concussion and in the paralytic stage of compression. A marked rise in blood-pressure follows any lesion, whether traumatic or non-traumatic, which produces an increase of the intracranial pressure and resultant anemia of the medulla (page 41).

The writer makes it a practice to have systematic blood-pressure measurements made at regular intervals (every half hour) in cases of head injuries.

A high blood-pressure is present in (*a*) acute compression of the brain from splinters of a depressed fracture, or from an extradural or subdural clot; (*b*) in fractures of the base of the skull; (*c*) in cerebral apoplexy.

A high and rising blood-pressure indicates progressive failure of circulation in the medulla and an increasing hemorrhage.

Hemorrhage into the anterior fossa of the skull has the least, while that into the posterior fossa has the most, effect on general blood-pressure. Uremic coma is accompanied by increased blood-pressure, so that this symptom cannot be utilized to differentiate uremic from apoplectic coma.

Acute Peritonitis.—The arterial tension rises in the early stages of acute peritonitis, and this sharp rise in blood-pressure may be of great value in making a diagnosis of typhoid perforation and other forms of incipient peritonitis.

[1] Nothnagel's "Spec. Path. u. Therap.," vol. ix.

[2] "Amer. Jour. of the Med. Sciences," 1902 and 1903.

CYTODIAGNOSIS.

This method of examination is of increasing interest to surgeons. It consists in the study of the character and number of the cellular constituents of exudates and transudates. For the technic of this method the many special text-books should be referred to.[1]

The conclusions obtained should never be employed as the sole means of making a diagnosis. It is and must always remain a single symptom. Cytodiagnosis is, however, of aid in the following fluids:

Cerebrospinal Fluid.—In epidemic cerebrospinal meningitis the fluid is at first clear, and gradually becomes more turbid. Polynuclear neutrophiles predominate in all stages, but in some the lymphocytes are in the majority.

In tuberculous meningitis, either mononuclears or polynuclears predominate, usually the former. All forms of purulent meningitis of traumatic or metastatic origin show microörganisms and typical pus cells.

In tetanus and in cerebral tumors there are no cells in the cerebrospinal fluid.

These findings enable one to make a differential diagnosis of acute spinal meningitis from tetanus, or from the cerebral symptoms of a tumor, or from the acute infectious diseases.

Pleural Fluids.—1. A predominance of lymphocytes means a tuberculous effusion.

2. A predominance of polynuclear neutrophiles means an effusion of an acute infectious origin.

3. A large number of endothelial cells, occurring especially in sheets or plaques, means a mechanical effusion or transudate.

4. In neoplasms of the pleura. Free tumor cells are often found in bunches. The cells are difficult to distinguish from leukocytes and endothelium, because both of the latter are also present in the exudate of a neoplasm. Karyokinesis speaks for a neoplasm.

There have been too few observations of joint, peritoneal, or pericardial fluids to draw any conclusions.

VACCINATION DIAGNOSTIC TESTS.

Closely allied to the opsonic estimation is the use of toxins in the determination clinically of the degree of resistance of an individual to a given disease. This reaction is most often used in tuberculosis. The oldest and at the present time the most reliable method is the use of the old

[1] Sahli: "Diagnostic Methods."

tuberculin of Koch. Positive reactions where no tuberculosis was present have so far failed when positive proof of the presence of tuberculosis was sought.

Theory of Causation for the Reaction.—The reaction is best explained on the theory that during or after the presence of a tuberculous focus in the body there are antibodies in the blood and tissues and a heightened power of the cells to produce them. Hence when suddenly an increased quantity of toxin is injected, an intense reaction of resistance occurs, locally and generally with febrile symptoms. Reactions may be very transient or last over a period of several days. Very important symptoms, such as may be interpreted as hyperemia, at the site of the local lesion, occur. The cough may increase, glands become tender and more swollen, and redness around an ulcer or sinuses occur.

Contraindication.—When the evening temperature reaches 100° or more. It is also cantraindicated when the patient has night-sweats, dyspnea, recent hemoptysis; general glandular involvement, meningeal, heart or kidney lesions, also after acute disease, or any unknown febrile reaction.

Results and Statistics.—This reaction is not specific for tuberculosis, but only of the fact that there is or has been a focus somewhere in the body. Healed foci usually do not react, but may for a long time give the reaction. The needle must be sterilized and the skin carefully cleansed. The reaction usually occurs in eight to twenty hours, and it is best to administer the tuberculin during the evening or late afternoon.

The patient should be kept in bed, preferably during the following twenty-four hours, and the temperature carefully recorded every two hours during the following two days at least.

Reaction.—In a typical tuberculin reaction, the patient begins to feel ill about twelve to eighteen hours after the injection. This indisposition increases, and he is willing to remain in bed.

Malaise, headache, pains in the back, extremities, gastric disturbances, and giddiness are often present. The temperature and pulse rise; the former, from 100° F. to as high as 105° or more in very severe cases. This method should be used only as a last resort, and only after all physical and laboratory methods have been exhausted.

Dosage.—The dose necessary to produce a reaction in a healthy individual is variously stated, but 0.01 c.c. never has caused a rise in temperature and may be stated as the upper limit of the test dose.

The initial dose depends on many factors, as age, size, condition of patient, etc. In children 0.0001 c.c. is a safe initial dose and 0.003 c.c. the maximal dose. In adults 0.001 to 0.010 c.c. may be given. Much smaller doses have been recommended and used by some authorities.

Method of Administration.—A proper dilution of the Koch tuberculin should be carefully made, so as to insure accurate dosage. The best dilution is one made by using 1 part of tuberculin (old of Koch) to 1000 parts of a one-fourth per cent. carbolic acid solution.

Von Pirquet Reaction.—Von Pirquet, of Vienna, observed that when individuals who had been vaccinated with cowpox for variola were again vaccinated, not a typical vaccination resulted after a period of five or six days, but a local erythematous reaction within twenty-four hours. This same phenomenon occurred in tuberculous subjects when vaccinated with tuberculin.

Technic of von Pirquet Reaction.—The old tuberculin of Koch is used best undiluted. The flexor surface for the forearm or outer aspect of arm is chosen for the site of vaccination. This is cleansed with ether. Two small drops of tuberculin are put in the part about 2 cm. or less apart, and a scratch with a sharp instrument made, first between them, then through the tuberculin, care being taken not to contaminate the non-tuberculinized area, as this is the control. The abrasion should be deep enough to open the lymphatics, but not draw blood. After a minute the excess of tuberculin is wiped away.

Reaction.—A hyperemia occurs in a few minutes, then an urticarial lesion; this is transient, and no part of the reaction. In from six to eight hours a hyperemia occurs, the area becomes elevated, edematous, and at its height, in from eighteen to thirty-six hours, a vesicle may form. This gradually subsides in a few days, no reaction having occurred in the control abrasion. There are no contraindications and the test is considered perfectly safe.

Value.—Is the same as in tuberculin injections except it is less positive, and old lesions are more likely to respond. It finds its greatest use in children under seven years of age. Here we are less apt to have old lesions present, and a reaction would speak for the presence of active disease somewhere in the body.

The ophthalmic reaction with tuberculin is founded on the same principle as the above, but not so safe. An ointment of tuberculin rubbed into the skin has given the same result, but is hardly more simple.

THE WASSERMAN DIAGNOSTIC TEST FOR SYPHILIS.

The essential principle of this test is the power of the serum of one animal to dissolve the red corpuscles of that of another animal. The hemolytic substance which is normally present in the fresh serum of every animal is called the complement. The latter is rendered inactive by heating it to 55° C. for half an hour.

When bacteria and other toxic agencies are introduced into the body there will be formed anti- or immune bodies also called amboceptors. These antibodies or amboceptors act as the intermediate link between the complement and the special microörganism or toxic agent. Such a microörganism or special toxic agent is called an antigen; its union with the amboceptors and all the available complement takes place, which precludes for that blood hemolytic action, if red corpuscles and amboceptors are subsequently added. If to the serum of a syphilitic, which has been rendered inactive by heating it to 55° C. for half an hour, we add an antigen, that is, extract of a syphilitic liver together with fresh serum complement, all of the latter is used up and further hemolytic action is precluded. In non-syphilitic serum, the antigen exerts no influence, because its antibodies are lacking, and when red corpuscles are subsequently added hemolytic action promptly takes place.

Lesser, in 2000 cases, has never found the reaction positive, unless there was a well-founded suspicion of its presence. The reaction is marked in many cases of scarlet fever, but this exception has no practical significance. A negative result does not argue against the presence of syphilis. It is best to employ a watery extract of a syphilitic liver. The reaction is not suitable for the differential diagnosis between chancre and chancroid, because it does not appear, as a rule, until after a three weeks' duration of the primary lesion is demonstrable.

In cases of progressive paralysis, Lesser has constantly obtained a positive reaction. In babes it was obtained in 56 per cent. of the cases. In the majority of cases it is possible to transform a positive into a negative reaction. Hence it is necessary to keep up the treatment until a negative action is obtained. Blaschko stated that it is present in leprosy, frambesia, sleeping sickness, severe diabetes, and after vaccination. One should make a serodiagnostic examination at intervals—several times a year in early years.

Wasserman has asserted from the beginning that only positive reactions are of value. In ordinary practice, alcoholic extracts from normal organs answer, but in laboratories for serodiagnosis a watery extract prepared according to the original directions should be kept on hand as a standard for control.

An excellent description of the technic will be found in a recent article in the April 10th, 1909, number of the *Cincinnati Lancet Clinic*, by Dr. M. L. Heidingsfeld of Cincinnati.

EXAMINATION OF THE SPUTUM, STOMACH CONTENTS, URINE, AND FECES.

The importance of a thorough examination of these secretions and excretions cannot be too strongly emphasized. They are of the greatest value from a diagnostic standpoint.

The results have been discussed in connection with the various injuries and surgical diseases in the preceding chapters. It is beyond the scope of a book of this character to describe the technical procedures. For the latter the reader is referred to the many standard treatises devoted to this purpose (Sahli, Boston, Simon, von Jaksch, etc.).

METHODS OF DIAGNOSIS OF RENAL LESIONS.[1]

CYSTOSCOPY.

Cystoscopy is the inspection of the inner surface of the urinary bladder, accomplished by means of appropriately constructed instruments. The patient is prepared for a cystoscopic examination in the following manner:

Technic of Cystoscopy.—In order to make a satisfactory cystoscopic examination three conditions are essential:

1. The caliber of the urethra must be free from stricture, or at least large enough to permit the easy passage of the cystoscope, which has a caliber of a No. 21 (French) sound in adults and of a No. 15 (French) sound in children. If a stricture is present, no effort at forcible dilatation should be made just before a cystoscopic examination. It is better either to dilate the stricture gradually or to perform one of the cutting operations (external or internal urethrotomy) before repeating the cystoscopic examination. If the external meatus is too narrow to permit the passage of the cystoscope, a meatotomy will quickly enlarge the orifice. In cases of hypertrophied prostate, cystoscopy is at times so difficult or accompanied by such constant bleeding as to render an examination impossible. In such cases one can use an irrigation cystoscope or a Schlagintweit cystoscope. The latter allows a much freer washing out of the bladder than an ordinary irrigation cystoscope. In these irrigation cystoscopes one can remove the lens system, irrigate the bladder, and then replace the lens again.

2. The bladder must be capable of holding at least 5 to 6 ounces of fluid. At times the bladder is so irritable—*e. g.*, in tuberculosis—as to make it impossible to distend it. One can overcome this either by injecting a weak (2 per cent.) solution of cocain or alypin into the posterior

[1] The sections upon Cystoscopy and Ureteral Catherization were written by Dr. Gustav Kolischer, of Chicago.

urethra and neck of the bladder. If a cystitis is present, so that a moderate amount of vesical distention cannot be tolerated, one must at times be content to examine the bladder with only a small amount of fluid in it, *e. g.*, 30 to 60 c.c. If the bladder is not capable of holding such a small amount, it is better to postpone the examination. Under no circumstances should one attempt cystoscopy during an attack of acute cystitis. In children, cystoscopy and uretheral catheterization are often impossible without general anesthesia. The beginner in cystoscopy should be warned against the possibility of producing a burn of the bladder mucosa, followed by an ulcer, through the use of a cystoscope in an imperfectly distended bladder.

In patients suffering from contracted bladder accompanied by great irritability or in some cases of advanced tuberculous cystitis, cystoscopy is often impossible. The same is true in large tumors or calculi which fill the greater part of the vesical lumen.

3. A transparent medium is absolutely essential in order to make a satisfactory cystoscopic examination. In some of the American cystoscopes or methods (Kelly) the bladder is distended with air. In the hands of those accustomed to the use of these methods, such air distention has proved very useful. In general, however, it is better to use water as a medium, and the bladder must be irrigated, when the urine is cloudy or bloody, until the fluid returns clear. It is unnecessary to use an antiseptic solution; distilled or sterilized water, moderately warm, is by far the most frequently employed medium to distend the bladder.

Further Points in Technic of Cystoscopy.—Correct posture is a great aid in cystoscopy. For those who perform it frequently, a special table is indispensable. The lithotomy position is necessary, with both legs flexed at the hip and knee and thighs supported by special rests. It cannot be denied that some experienced cystoscopists can examine equally well when the patient lies on the back with limbs extended and well abducted, but this is less satisfactory than the position referred to above. Every manipulation must be performed with as rigid a regard for asepsis as possible. The external meatus must be carefully washed off and a sterile catheter used for irrigation. It is impossible to sterilize a cystoscope by boiling without loosening the lenses, so that it suffices to immerse it almost completely in an upright position in a pitcher filled with ½ per cent. lysol solution (one-half teaspoonful of lysol to a quart of water). Ureteral catheters are best sterilized by placing them in the steam or formalin sterilizer for half an hour. The best methods for keeping both urethral and ureteral catheters sterile in the intervals between use, is to keep them either in a special long glass cylinder, to be obtained

at all surgical-instrument houses, or to keep them in sterile towels with a pocket for each catheter.

The only medium to be employed for lubricating metallic instruments and urethral catheters is sterile glycerin. Ureteral catheters require no lubrication.

In some cases the fluid used for preliminary irrigation of the bladder returns clear, but soon after the cystoscope is introduced the view becomes indistinct. This is either due to the fact that some particle of mucus or pus adheres to the lens, or that pus escapes so rapidly into the bladder from the ureter or some diverticulum as to rapidly render the medium turbid. A shred of mucus or pus is best removed by pulling the instrument out a little distance and rubbing the lens against the internal meatus. If this does not suffice, it will be necessary to pull it out completely and wipe it off with a soft cloth. If there is much mucus or pus in the urethra, it will be necessary to irrigate it. In some cases the persistence of turbidity in the bladder despite repeated irrigation makes it necessary to postpone the examination. The cystoscope should be tested before insertion by turning on the current and placing the beak of the instrument in a glass of water. One can either employ a storage battery as the source of electricity, or, better still, convert the ordinary street current as obtained in cities into the amount required, by the use of a special rheostat. Enough current should be turned on until the filaments of carbon in the lamp are invisible. After testing the lamp the current is turned off again and the cystoscope introduced. The current is now turned on again. In order to avoid burning the lamp out too quickly, it is best, after testing the amount of electricity required to give a good light, to leave the rheostat screw at the proper notch until the cystoscope is introduced.

At times, after the cystoscope has been inserted into the bladder and the current turned on, the field is dark. This is usually due either to imperfect distention of the viscus, or more frequently to the fact that the instrument has been inserted too far, so that a portion of the mucosa is pushed out like a diverticulum. In such cases the beginner thinks that insufficient current has been turned on. He will increase the amount and quickly burn out the lamp. It is best under such circumstances to shut off the current, pull the instrument out a little distance, and then turn on the current again. Every portion of the bladder mucosa should be systematically inspected by slowly rotating the instrument around its long axis and then raising and lowering it. Finally it should be inserted to different depths.

In patients suffering from enlargement of the prostate the prostatic urethra is often so elongated and widened as to permit free rotation of the

instrument. If the field is dark or dark red, the beak is still in the urethra, unless the prism is covered with blood. The current should be turned off, the handle depressed considerably, and the current turned on again. The movements of the handle in the various directions should always be made slowly, care being taken not to swing it too widely and rapidly in order to avoid contact of the lamp with the bladder mucosa. Such wide and rapid excursions of the handle are quite painful, owing to the fixation of the membranous urethra (Casper). In order to inspect the internal

FIG. 560.—NITZE'S CYSTOSCOPE EXAMINING BASE OF BLADDER.

meatus and neck of the bladder, it is necessary to use the retrograde cystoscope. Of these, the best is that of Schlagintweit. After the cystoscopic examination there may be some vesical irritability, which is best controlled by the use of small doses of extract of opium (gr. $\frac{1}{8}$) and extract of hyoscyamus (gr. $\frac{1}{10}$) given in the form of a suppository.

Cystoscopes.—Two classes of instruments are in general use: (*a*) those which depend upon the use of an electric lamp and a lens system at the vesical end of the instrument, and (*b*) those in which the source of

light is external to the instrument and there is no lens system. To the latter class belongs the instrument of Kelly, which in the hands of its inventor and a few others has proved itself to be extremely useful for the inspection of the female bladder as well as for catheterization of the ureters. It has, however, been supplanted in the case of the majority of surgeons by the class of instruments of which the cystoscope of Nitze is the type.

Nitze was the first to suggest the use of a lens placed in the beak of the instrument for magnifying the field. He combined this principle with the use of the small incandescent lamp as the source of light. The Nitze instrument consists of a shaft and a removable tip (Fig. 563). In the latter the incandescent lamp is placed so that, if it burns out, another can be readily inserted. Into a double groove close to the end of the instrument the clasp of the conductor fits. This clasp can be slipped off or on as required, and is equipped with a sliding switch for turning the electricity on or off, as required. A rectangular lens (*b*) is inserted at the angle formed by the shaft and beak. By this means the field *e d g* of Fig. 561, which would ordinarily be seen without the use of a rectangular lens, is transferred to *i h k*. The hypothenuse of this rectangular lens is a mirror, so that all objects seen through it are reflected toward a lens system placed in the shaft of the instrument and carried to the examiner's eye, placed at the outer end of the cystoscope. The wires carrying the current are placed along the wall of the interior of the shaft and are completely insulated from the lens system. They connect at the beak with the lamp and at the outer end with the removal clasp described above.

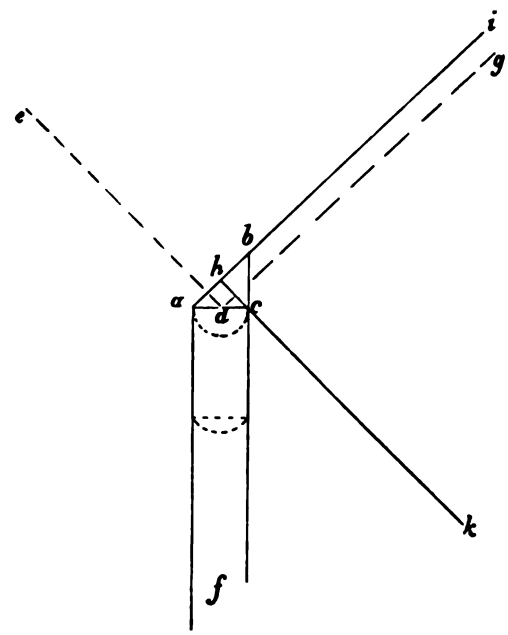


FIG. 561.—ACTION OF RECTANGULAR LENS IN NITZE'S CYSTOSCOPE.

The rectangular lens *a*, *b* *c*, placed at the angle between the beak and the shaft of the Nitze cystoscope, changes the field of vision in such a manner that instead of seeing a field included by the lines *e*, *d*, *g*, the lens changes the field so that the portion of the bladder seen is *i*, *h*, *k*. (See text.)

Under special conditions, the vesical end of the posterior urethra also becomes accessible to inspection. Modern cystoscopy rests upon the following principles:

(*a*) The viscus is dilated by means of a transparent watery fluid which has been injected into the bladder—usually distilled water.

(*b*) Through the insertion of an incandescent electric light into the bladder, and the enlarging of the virtual picture, either by a lens inserted in the instrument used or through the combination of a prism and lens by means of a telescope-like arrangement (Figs. 562 and 563).

The cystoscopes most often used belong either to the group which furnish inverted pictures or they belong to a second group which furn-

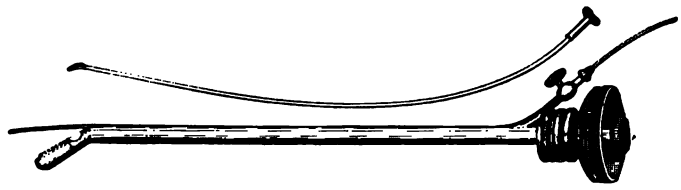


FIG. 562.—BRENNER'S URETER-CYSTOSCOPE.

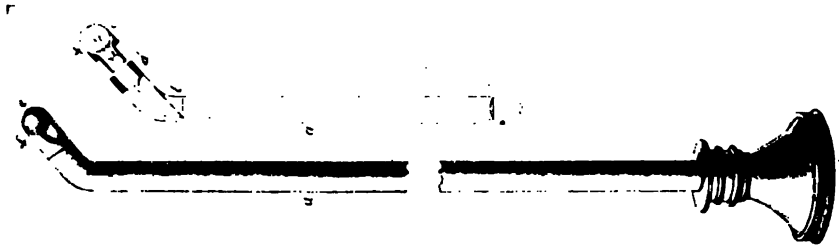


FIG. 563.—NITZE'S CYSTOSCOPE.

a, Shaft; *b*, rectangular lens (see Fig. 561); *e*, *f*, lamp which can be unscrewed from remainder of the beak at *d*; *c*, lens inside of shaft.

ish a direct view, that is, an upright picture. To the first-mentioned class of instruments belongs the so-called retrospective cystoscope, which by a peculiar optical arrangement, permits the inspection of the internal orifice of the urethra and of the extreme inner part of the posterior urethra. The addition of conducting canals converts the cystoscopes into instruments which can be used for ureteral catheterization and for operative procedures.

The second group of cystoscopic instruments includes those which furnish a direct view, that is, upright pictures. The addition of conducting canals transforms these instruments also into cystoscopes which

can be employed for ureteral catheterization and for endovesical operation as examples of this class.

In order to determine the topographic location of various lesions we resort to conclusions drawn from (*a*) the position of the ocular end of the instrument, and (*b*) from the relation of the lesion under question to certain landmarks on the inner surface of the bladder.

A little knob soldered to the circumference of the ocular part of the cystoscope, in the same sagittal plane as the convexity of the beak, indicates the position of the cystoscopic window, and thus the location of the object in view.

A further more precise determination is furnished by the following intravesical landmarks:

1. The internal orifice of the urethra. It appears under normal conditions as a crescent-shaped fold of dark red color, only slightly glossy, and of velvety surface.

2. The interureteric ligament. It presents itself as a small band, more or less prominent, running in a transverse direction through the field of view covering the trigonum.

3. The ureteral openings, appearing at either end of the above-described band.

4. The air-bubble, naturally always floating on top of the fluid, thus indicating the vertex of the bladder. This bubble shows silvery reflexes, is translucent, and in its center the reflex of the incandescent light is to be seen; it oscillates according to the respiratory movements.

The normal color of the mucosa of the bladder is a light yellow with a pinkish or grayish tinge, and the ramifications of the blood-vessels are distinctly to be seen (Fig. 563 A); the surface of the vesical mucosa is smooth and glossy, and any deviation from one or from several of these conditions points to pathology.

The ureteral openings appear normally as fine slits of a somewhat darker color than the surrounding mucosa. Only during the ejaculations of urine are these slits transformed temporarily into holes.

A ureteral opening of a dark red color or a permanent gaping of the ureteral mouth is pathologic.

Cystitis.—Acute inflammation of the mucosa characterizes itself by the change of the normal color to a red of different shades, and by the disappearance of the blood-vessels in the affected areas. In the adjacent parts, the blood-vessels appear to be injected and dilated. The intensity of the reddish coloring of the mucosa is in proportion to the intensity of the inflammatory process.

In cystitis that occurs in circumscribed patches, areas of mucosa of

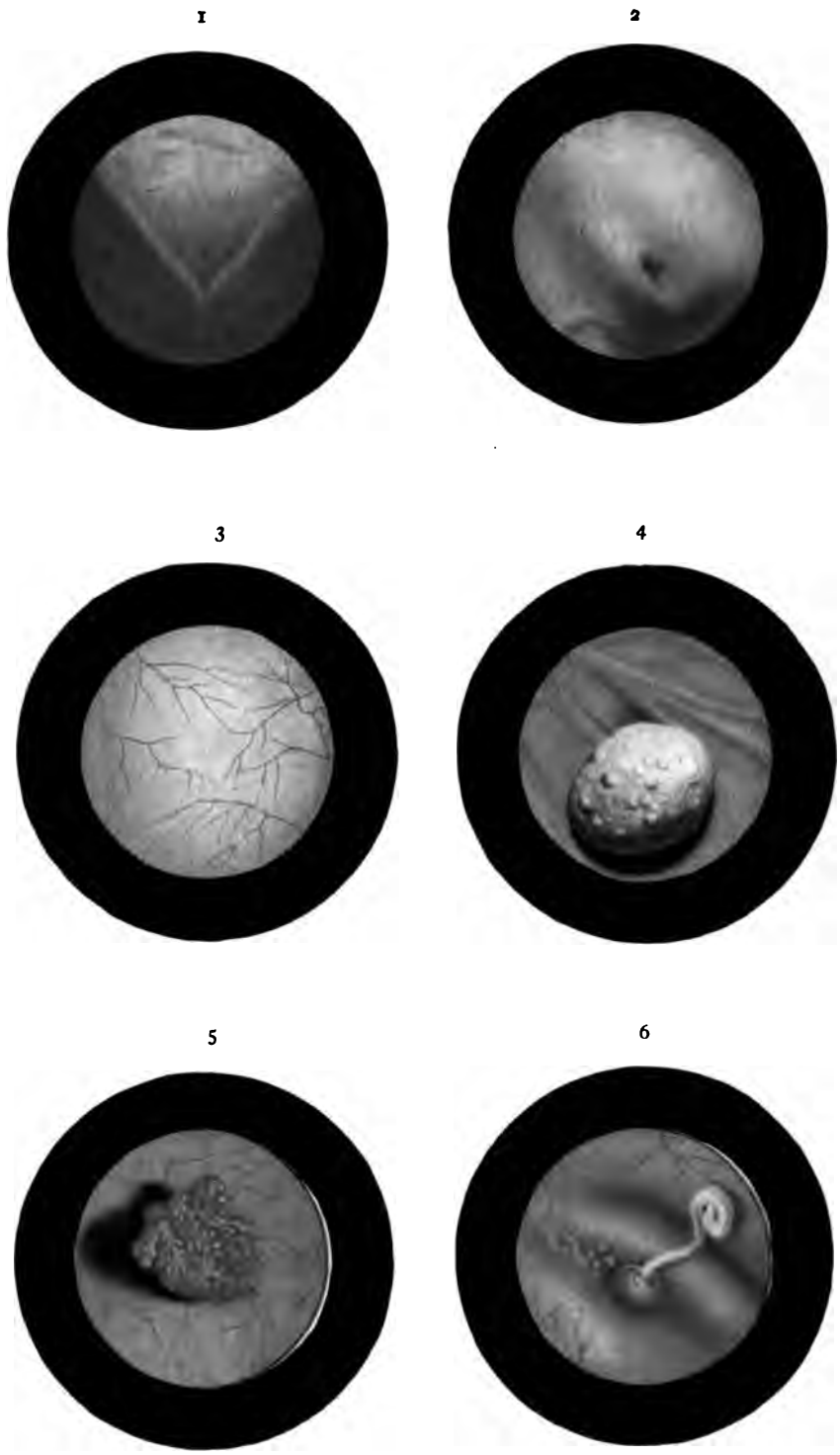


FIG. 563 A.—CYSTOSCOPIC VIEWS OF VARIOUS PATHOLOGIC CONDITIONS (Nitze[1]).

1, Prostatic hypertrophy; 2, ureteral orifice; 3, normal bladder mucosa with arteries and veins; 4, vesical calculus; 5, papilloma of bladder; 6, ureteral orifice with pus escaping from it.

[1] *Kind permission* of publishers of Nitze's "Lehrbuch der Kystoskopie."

normal appearance separate the dark spots; if the cystitis is of a general character, large areas appear dark red, without showing any blood-vessels, or the whole surface of the mucosa is dark red, and of a velvety appearance.

In case of intense inflammation, shreds of epithelium are attached by one end to the inflamed areas, and submucous hemorrhages are to be seen in the immediately adjacent parts.

Acute gonorrheal cystitis is characterized by the fact that the trigonum is predominantly involved.

This appears to be studded with red spots of various sizes; the greatest intensity of coloring is found in the centers of these blotches, the color tapering to pink in the periphery of these foci.

Chronic cystitis is characterized by the changing of the red color of acute cystitis into a more brownish shade, the surface of the affected parts being without any gloss whatever, and the hemorrhagic spots appearing black.

The mucosa is quite often swollen and raised into thick clumsy folds, giving the beginner the impression at first, of a neoplasm. Such folds can be differentiated from papillomata in the following ways: Papillomata have not such a broad insertion and are, at least at their ends, translucent; and if transillumined show very distinctly their blood-vessels, while folds of the swollen mucosa are absolutely opaque.

The products of cystitis in chronic cases appear either as lumps of a whitish appearance and of a rough surface, attached to discolored parts of the mucosa, or they cover, formed into membranes, the dependent parts of the bladder.

In some cases of long standing, the chronic inflammation leads to the formation of villous excrescences around the internal urethral orifice and on the adjacent parts of the bladder entrance.

These formations remind one of a glove in miniature. They are not transparent, and give distinctly the impression of jelly-like infiltration.

Cystitic Ulcers.—They appear in the cystoscopic view as depressions upon round elevations; their floor is covered with a grayish coat; and the elevations are located in cystic brownish-colored areas. Their favorite location is in the trigonum.

Tuberculosis of the Bladder.—A. *Tuberculous Catarrh or Tuberculous Parenchymatous Cystitis.*—A large area of the mucosa appears to be reddened. The blood-vessels in the involved area are not to be seen, the whole surface being smooth and giving the impression of a gelatinous swelling. Numerous ecchymoses are also to be seen. The inflamed area is extremely sensitive to the touch and the capacity of the bladder is always markedly reduced. This picture, of course, in-

dicates only a suspicion of tuberculosis. The final diagnosis can only be made by finding tubercle bacilli in the urine.

B. *Nodular and Ulcerative Tuberculous Cystitis.*—In the trigone one most frequently sees nodules of different sizes, varying from the size of a hempseed to that of a lentil. These nodules are of a grayish or yellowish color, surrounded by a dark red margin.

Some of these nodules are broken down in the center, so that small ulcers result. Their edges are undermined, raised, and ragged. In more advanced cases, two or three of these ulcers may become confluent, thus forming a larger ulcer of irregular outline. The floor of these ulcerations is covered by pale, irregular granulations, which bleed very easily.

If these nodules or ulcers are grouped around a ureteral opening, or if the ureteral mouth shows signs of inflammation, if it is gaping, red, and its lips swollen, or, if the ureteral opening forms the central part of such an ulcer, the diagnosis of descending tuberculosis, originating in the kidney, is almost certain (see page 417). Here again the final diagnosis rests upon finding tubercle bacilli.

C. *Tuberous Form of Tuberculosis.*—We see one or two solitary tumor-like excrescences of various thickness and height protrude from a red, darkened area of the mucosa: The top of such a prominence always carries an ulcer, with puffy, ragged edges; its bottom is covered by easily bleeding granulations. This form of tuberculosis preferably appears near the internal orifice or in the vertex of the bladder.

Solitary, i. e., Simple Ulcers (see page 839).—These ulcers may appear anywhere in the bladder. They are surrounded by apparently healthy mucosa of normal color, gloss, and vascular ramification. Their contour is quite round, the edges are sharp, and the floor is covered with solid red granulations. The ulcer is below the level of the mucosa, and appears as though stamped out of the mucosa with a sharp die. These ulcers are rare, and appear almost exclusively in young individuals.

Edema of the Bladder.—In *general edema of the bladder*, the mucosa appears to be thrown up into thick clumsy folds. The color, if no acute inflammatory conditions of the mucosa coexist, is whitish. The blood-vessels are not to be seen. The surface, especially the crest of the folds, appears as if covered with a glistening white scum.

Circumscribed edema shows limited areas of the mucosa separated at the surface, so that the affected part of the mucosa appears like a flake of wet, white absorbent cotton (retrostrictural edema).

Inflammatory tumors of neighboring viscera, in becoming attached to the bladder wall, produce a certain kind of circumscribed edema, which is peculiar to the bladder mucosa. On account of the characteristic appearance and the pathology, it is called *bullous edema.*

The affected area of the mucosa appears to be covered with any number of translucent globules, whose size vary from that of a lentil to that of a large pea. In different places, whitish flakes, attached by one end to the mucosa, float in the fluid which has been injected into the bladder.

If these globules are closely crowded together, the entire affected parts offer the appearance of a cluster of small grapes. The base and the adjacent mucosa appear reddened, quite often wrinkled.

If the inflammatory tumor which has produced the condition pushes the bladder wall into the lumen of the viscus, and if a great many of these globules have burst on account of the tension, the whole affection may be mistaken for a neoplasm.

Prostatic Hypertrophy.—Changes in the size and formation of the prostate gland can be diagnosed through the aid of the cystoscope, if the vesical surface of the prostate is the main seat of the affection.

Any change in the normal, crescentic, sharp outline of the internal orifice, as it appears in the cystoscopic view, points to abnormalities in the prostate.

It is, however, important to make allowance for an indentation of the urethral canal, if the ocular end of the cystoscope is markedly elevated.

If one lateral lobe of the prostate is enlarged, one side of the circumference appears to be elevated and protruding into the field of view.

If such a lateral lobe is considerably enlarged, and grows into the bladder, a prominence in the so-called vesical neck is to be seen. If prostatitis is present, the mucosa covering this prominence appears edematous. If both lateral lobes are enlarged, the aspect of the internal orifice is changed into a V-shape. If both lateral lobes grow into the lumen of the bladder, several prominences elevating the mucous membrane of the trigone are to be seen. If the median lobe is moderately and uniformly enlarged, the crescent-shaped outline of the internal orifice of the urethra appears to be flat.

If this uniform enlargement reaches a higher degree, the concave outline of the internal orifice is changed into a convex one.

If the median lobe becomes pedunculated, and if the upper part of it continues to enlarge, the cystoscope reveals a pedunculated valve hanging across the internal meatus.

A uniform enlargement of the prostate not only changes the outline of the internal orifice or meatus into a straight or even into a convex line, but it also shows the base of the bladder as a deep depression, whose bottom appears dark on account of the shadow. All these findings

are more distinctly and markedly seen if the retrospective cystoscope is used.

In case arteriosclerosis is the cause of the prostatic symptoms, thick, rigid-appearing blood-vessels are to be seen scattered through the mucosa covering the prostate; these blood-vessels spring into prominence like strands buried in the mucosa.

As a rule, we see tiny blood-streams trickling down from those places, which were touched in introducing and manipulating the cystoscope.

Vesical Calculi.—Bladder stones present themselves in the cystoscopic view as well-defined foreign bodies, that distinguish themselves sharply from the bladder wall (Fig. 563 A).

As to any conclusions regarding their size, it must be remembered that only at a certain distance (varying according to the lens system employed) from the window, objects will appear in their natural size, otherwise they become magnified in the cystoscopic observations. Furthermore, if a concretion is so large that it extends beyond the cystoscopic field of view, we only get a constructive picture of the whole stone; but we can always arrive at a pretty accurate conclusion as to the size of the stone if we observe its distance from, or its extension over, the aforementioned normal landmarks inside of the bladder (see page 838).

Further information as to whether a stone is freely movable or partially embedded between folds of mucous membrane, or whether it is encysted to any extent in a diverticulum, can be gained by using a ureteral or operative cystoscope through whose conducting canal we introduce a sound or a forceps.

By trying to move the stone or by dislodging it, all points may be cleared up, upon which we desire information. With the aid of the cystoscope, we observe the color of the concretion, the quality of its surface, and its general formation. • Phosphates and lime-stones appear as white foreign bodies, which, as a rule, are egg-shaped.

Urates show a yellowish color and a round form. Oxalates are either brown, or of a blackish-brown; occasionally they show a black-greenish tinge. Their general formation, as a rule, is rather irregular, their surface is granular, and in marked forms they appear like mulberries.

The cystoscope decides very readily whether only one or many stones are present. If we discover facets on the surface of one, this is a strong indication to look for other calculi. If cystitis or traumatic ulcerations are present, we discover these readily by ocular inspection. In a differential diagnostic way, large blood coagula or pus coagula deserve to be

mentioned. Blood coagula have quite a characteristic yellow, leathery appearance; their surface is absolutely smooth, much more so than that of any stone. Large masses of pus appear to reflect light strongly, almost white, like small snowballs, and their surface shows a very loose structure.

Tumors of the Bladder Wall.—Neoplasms of the bladder appear in the cystoscopic field as protrusions that are attached to the bladder wall at one end, and extend into the lumen of the viscus at the other. *This standing out in relief, is characteristic of neoplasms.* It is very pronounced, when the tumors are pedunculated. If the tumors are attached to the bladder wall by a broad base, it is less pronounced. If a neoplasm infiltrates the bladder wall, this standing out in relief is not very marked. In the latter case, a preliminary symptom is quite characteristic, viz., when we try to dilate the bladder by injecting water by means of a hand-syringe, we experience an exquisite sensation of rigid resistance. The cystoscopic pictures are very clear, easily recognized and classified, if no cystitis is coexistent. The tumor-mass, not showing any blood-vessels, and being of a different color, can be differentiated very readily from the normal mucosa. The impression of something solid, is strengthened by the appearance of the shadows that are cast by the tumor over the mucosa.

These shadows change their position according to variations in the position of the cystoscopic beak. Swollen, thick mucosa folds may occasionally simulate neoplasms. The following points will aid in distinguishing these swollen folds of mucous membrane from tumors: The folds when swollen are always multiple, which is rather rare in the case of tumors. The folds appear as diffuse swellings, while neoplasms appear to be more sharply defined. Swollen mucosa folds show over their entire surface, a whitish, glistening scum.

Malignant tumors, as a rule, ulcerate on their surface, and then present on their summit an irregularly shaped ulceration, which almost uniformly bears incrustations. If a neoplasm occurs in an inflamed bladder, or if a neoplasm is ulcerated, a certain method must be employed in order to obtain good views. After the instrument is introduced, it must be kept quiet for a while, so as to give the particles of débris and pus floating in the fluid a chance to settle down to the most dependent parts of the bladder.

The so-called villous polypi or papillomata of the bladder give very beautiful and characteristic views. As a rule, they grow from a common pedicle, which divides into several branches. These show a leaf-like appearance, and float around like water-plants in the fluid which has been employed to fill the bladder.

If the light is allowed to pass through these leaves they show quite distinct long loops of blood-vessels. Some of these tumors show at their edges, a fimbriated condition.

All these tumors are of a benign nature, and contact may produce free hemorrhage. Other tumors imitate the shape of a mushroom.

Malignant tumors show, besides the ulceration already referred to, an irregular surface, there being recesses or excavations as well as hemorrhages into the adjacent mucosa. An extensive phlegmon of the mucosa in its initial stages can hardly be differentiated from an infiltrating cancer in the cystoscopic view. The diagnosis can, however, be made from the accompanying symptoms of each condition.

Encrusted tumors may occasionally be mistaken for calculi and vice versa. The employment of an operative cystoscope and the manipulation of the questionable object by a forceps introduced through it will assist in making a differential diagnosis.

In rare cases, a blood-clot attached with one end to the bladder wall and floating around with its free end, may be taken for a papilloma. Close observation of its surface, and the lack of any translucency, even at the edges, will finally settle the diagnosis.

Parasites in the Bladder.—Parasites lying upon or in the bladder wall produce a cystitis of the following character: The cystoscope shows reddish patches disseminated all over the inner surface. Adherent to the centers of these foci of inflammation are whitish or yellowish granular areas. These granules are not as flat as the covering of ordinary ulcers, but protrude into the viscus, and show strong reflecting power. These granules are formed by the mycelia of the parasite, whose character must be determined by microscopic examination of the urine.

Syphilis of the Bladder Wall.—Syphilis of the bladder produces various cystoscopic pictures, according to the lesions present. Broad condylomata (mucous patches) appear as yellowish prominences of the form well known in the skin. Syphilitic ulcers do not differ from those of other infections in appearance. Gummata elevate the mucosa, and after breaking down, show central ulcerations. The diagnosis can only be made positive through antisyphilitic medication.

Leukoplakia of the Bladder.—This condition manifests itself in the cystoscopic view by the appearance of white patches, located in the trigone or at the junction of the base of the bladder with the fundus, These patches are somewhat prominent above the surface of the mucosa, are of oval or circular shape, and vary in diameter from 3 to 6 mm. The surface of these patches appears to be of solid, dense structure. If these patches are in a condition of reaction, showing a lighting up

of a cystitis, they have a scarlet-red small periphery, and the blood-vessels in the adjacent mucosa appear to be injected.

Patent Urachus.—In this condition we see at the top of the bladder a round hole, surrounded by a rim of protruding, highly vascularized, smooth, shiny mucosa. The center of this opening is dark. A ureteral catheter introduced into this shadowy center proceeds without any obstruction for several inches in an upward direction.

In case inflammation has occurred around the opening of the urachus into the bladder, the ring of mucous membrane encircling the opening appears to be swollen; ribbons of detached epithelial covering project into the lumen of the bladder, and pus flakes are seen to drop from the opening of the urachus into the bladder. In the mucosa adjoining the opening numerous submucous hemorrhagic patches are to be seen.

Abnormal Communication of the Bladder with Some Preformed Cavity or Some Perivesical Area of Infection, etc.—The perforation of a pelvic abscess into the bladder is marked in the cystoscopic picture by a bulging of the affected bladder area into the lumen. If the exudate is still under high tension, this part of the mucosa is covered with edema bullosum (see page 840). If the tension has relaxed considerably, the mucosa appears to be generally swollen, but, as a rule, a few pearls of circumscribed edema are to be noticed, in the otherwise generally edematous mucosa.

The perforation appears as a ragged hole, whose edges are everted. The border is covered with pus flakes and with ribbons of the detached epithelial layer. The adjacent mucosa is dark red, the vascularization being no longer visible. Ecchymoses are numerous, and quite often we see a thin stream of pus running down into the bladder. Pressure on the inflammatory tumor increases the flow of pus into the bladder. The pus accumulates in the trigone and fundus, and appears there as a white, strongly reflecting mass.

The *perforation of a pyosalpinx* shows a similar picture, but the bladder wall, as a rule, is involved in the inflammatory changes only to a very limited extent. As a rule, no flow of pus into the bladder is to be noticed. Pressure on the pyosalpinx makes corrugated, sausage-shaped strands of pus appear in the perforation. If the pressure is kept up, these strands accumulate and are arranged in loops at the fundus, thus giving the appearance of a network of white, strongly reflecting strands.

The *perforation of a dermoid cyst* shows similarly an opening surrounded by the signs of contiguous inflammation. Either bunches of hair, covered with caseous masses, or parts of the bony skeleton can be seen protruding into the bladder.

Vesicorectal fistulæ may become the object of cystoscopic examination if the fistula is a tortuous one, or if the rectal fistulous opening is so small that it can easily be closed temporarily by packing. In either case it becomes possible to dilate the bladder for a sufficient length of time to permit a cystoscopic examination to be made.

The vesical opening of such a fistula always appears like a crater, drawn in toward the bowel, so that concentric longitudinal folds of mucous membrane appear. The border of the fistula appears to be smooth and the mucosa tense over it. The signs of inflammatory reaction around the fistulous opening are very slight. Once in a while fragments of feces may be seen adherent to the edges.

Vesicovaginal fistulæ can be rendered accessible for cystoscopic examination either by clamping together the edges of the communication or by tightly packing the vagina with wet cotton.

The vesical opening of the fistula is always surrounded by an inflamed area of mucosa; the most important feature of this examination is to determine what relation the ureteral openings bear to the fistula.

The *communication of the bladder with a loop of intestine*, as a result of the perforation of an intestinal carcinoma into the bladder, gives quite a striking picture.

In the fundus, or in the vertex of the bladder anywhere, we see a dark excavation of varying size. This recess shows a double border. In the inner part, the smooth mucosa of the intestine, shiny and pinkish, protrudes into the viscus. In some places we see ulcerated portions of the neoplasm. Irregular craters with a discolored base, their edges ragged, and ribbons of necrosing tissue floating from their periphery, are seen. The outer ring of the edge is formed by the vesical mucosa. It appears to be dark, velvety red, and submucous hemorrhagic patches are to be seen. The adjacent mucosa is characterized by a very dense network of the finest blood-vessels.

Hemorrhoids of the Bladder.—Simple dilated large veins appear in the cystoscopic picture as meandering blue strands of various caliber; they quite often protrude above the level of the mucosa. True "hemorrhoids," that is, well-developed phlebectasias, parietal dilatations, or pockets in the veins, give different cystoscopic pictures, according to their relation to the cystoscopic beak.

If the light strikes them from the front or diffusely, they appear as well-defined blue globules with a smooth surface. If they are transillumined from behind, they appear as reddish, somewhat transparent globules, that frequently carry a dark center ("phleboliths"). Once in a while a floating-blood coagulum is seen to be attached to the periph-

ery of such a nodule. In order to test the functional capacity of the two kidneys, several methods are in use:

URETERAL CATHETERIZATION AND EXAMINATION WITH SOUNDS, ETC.

The urine from each kidney can be collected separately by means of elastic catheters inserted into the ureters.

The catheters used for ureteral catheterization are about 30 inches long and are about the same size as a No. 5, 6, 7, or 8 Charriere sound. The best catheterizing cystoscopes are those of Nitze, Brenner, Casper, and Albarran (see Figs. 561, 562, and 563). The principle underlying each of these instruments is the same. Along the upper or under surface of the ordinary cystoscope runs a tunnel which opens just short of the prism window. When the ureteral catheter is passed along this tunnel and projected from the opening, the point of the catheter is seen on looking through the prism, and may be guided into the utereal opening. For catheterization of the ureters certain conditions are requisite: a clear medium, sufficient distention of the bladder, and an anesthetic urethra. The patient lies upon his back on a couch or operating table with the pelvis raised. Ten minutes before commencing the examination 20 minims of a 2 per cent. solution of cocain or a $\frac{1}{4}$-grain tablet of alypin are instilled into the prostatic urethra with a Guyon's syringe.

Where the bladder is healthy, no preliminary washing is required. A gum-elastic catheter lubricated with glycerin is passed, and the bladder is slowly filled with warm boracic lotion by means of a hand syringe until twelve ounces have been introduced. Where cystitis is present, careful and painstaking washing is necessary. The wash is examined in a glass vessel from time to time to note progress, and the surgeon should not rest satisfied until a clear medium is obtained. Bleeding during the washing is best treated by using a very weak solution of silver nitrate (1 in 10,000 or 15,000). The silver solution is followed by further irrigation with boric solution. A distention of twelve ounces should be aimed at, for with this the ureters are readily approached. In the female bladder a good distention is especially necessary, and the pelvis should be well tilted, for the bladder base, from its relation to the vagina, lies on the same plane as the floor of the urethra, and it may be difficult to raise the beak of the instrument away from the floor of the viscus so as to maneuver the catheter into the opening of the ureter.

The lamp of the catheter cystoscope is now tested and the ureteral catheter placed in the tunnel, the point lying just within the distal open-

ing. Glycerin is used as a lubricant, and the catheter must glide easily along the tunnel. The instrument is well lubricated and introduced into the bladder. The passage of the cystoscope must be carried out with extreme care, for the high shoulder tends to hitch at the entrance to the bladder, and may cause bleeding, which will obscure the view. In the male subject a full depression between the patient's thighs is necessary, and at the same time a pushing movement is imparted to the instrument. On reaching the bladder the beak of the instrument is turned downward, —with the exception of the Brenner instrument, which does not require this,—the light switched on, and the interureteric bar comes into view. This will be recognized by the appearance of a low transverse ridge, or by the darker color frequently imparted by the more abundant blood-supply of the trigone. The bar is followed outward to one or other side by rotating the instrument, and the red, slit-like opening of the ureter comes into view.

When the ureteric opening comes into view, the cystoscope will lie with its long axis in the middle line of the body and the beak twisted toward the side of the observed ureter. By carrying the ocular end of the instrument toward the opposite thigh, the window and catheter opening will be found to approach the ureteric opening. The window now lies above and slightly to the inner side of the opening. The catheter is pushed on so that the point lies about the middle of the field of vision. Most of the maneuvering should be done with the cystoscope as a whole, and the elevation and pushing on of the catheter left for the final stage, when the window is close to the opening. The orifice should be approached from above and from the median side. The catheter sinks between the lips of the opening and is slowly and gently pushed onward by the disengaged thumb and forefinger of the right hand, the left hand meanwhile steadying the ocular end of the instrument and holding it firmly in position. As the catheter enters the ureter and passes along the submucous part of the ureter the outer end of the ureteric ridge beyond the orifice of the duct is raised up for one-eighth of an inch or more. If it is intended to catheterize both ureters and a double-channel cystoscope is being used, the beak is now turned toward the second ureter and the ocular end of the cystoscope moved toward the opposite thigh. The same maneuvering is carried out on the second side that has been detailed in describing the passage of the catheter into the first ureter. When the second catheter is in place, the elevator is lowered, the light is switched off, and after pushing some slack catheter into the bladder the cystoscope is gently withdrawn.

Each catheter is fixed with a piece of adhesive plaster to the inner surface of the thigh of the side to which it belongs. If this is not done, they are easily crossed in the urethra, and it is impossible to tell to which kidney either catheter belongs. A bottle labeled "right" and another "left" is placed between the thighs to receive the ends of the catheters. The first fluid is discarded, for some of it is derived from the fluid filling the bladder. It is not always necessary to catheterize both ureters.

The urine which passes from the catheters flows in a continuous stream when the eye is in the bladder, but when it lies in the ureter it drips away intermittently. There are four to six drops in rapid succession, then a pause of about six seconds, and then another succession of drops.

The tip of the catheter should only extend beyond the vesical end of the ureter a distance of 4 to 6 inches. If the catheter has not been passed

FIG. 564.—CATHETER APPROACHING URETERIC ORIFICE.

FIG. 565.—CATHETER LYING IN URETER.

(From "Estimation of the Renal Function in Urinary Surgery," by J. W. Thomson Walker, M. D.)

into the pelvis of the kidney, urine is ejected from the distal (*i. e.*, external) portion of the catheter at intervals, just as it is normally from the ureteral orifice into the bladder. If the tip of the catheter extends into the pelvis of the kidney the urine drips out in a continuous stream. At times the insertion of a ureteral catheter is followed by a temporary reflex anuria. The flow of urine through the catheter may also be obstructed by a plug of mucus or pus, arrested in the catheter. This can be overcome by injecting some sterile water into the catheter. If blood appears in the urine which is being collected, the tip of the catheter should be pushed a little higher up, so that it is possible to exclude an injury to the ureteral mucous membrane as the result of the passage of the catheter. In case it should be impossible to catheterize one ureter, or if it be considered undesirable to catheterize the ureter of the presumably healthy side, the so-called occlusion balloon catheter [illegible] employed. This is a ureteral catheter

whose eye is covered by a very thin rubber membrane. After this catheter is inserted into one ureter, the rubber is inflated by means of a syringe, and after the inflation is finished the distal end of the catheter is tied. In this way the catheterized ureter is plugged, and the urine coming down from the opposite kidney is collected in the bladder and can be drained out by an ordinary catheter. Previous to the act of collecting the urine, the bladder must be carefully irrigated, and then emptied.

If it is necessary to make a differentiation between a complete severing of a ureter and a ureteral fistula, which involves only a part of the ureteral wall, ureteral catheterization will solve this problem in the following way: In case of a complete lack of connection between the distal ureteral stump and the proximal end of the ureter, it will be impossible to pass the catheter beyond the region of the fistula, and at the same time the distal opening of the catheter will remain dry. If only a parietal, *i. e.*, partial lesion of the ureter is present, the catheter will quite often slip over this place beyond the region of the tangential fistulous opening, and urine will come down through the catheter.

The emptying of a fluctuating tumor occupying the renal region, through the insertion of a ureteral catheter inserted high up, will serve to identify this tumor as a renal one. In case it should be desirable to measure the length of that portion of the catheter which is inserted into the ureter, a so-called zebra catheter is employed. This is a catheter whose surface is marked in turn by yellow and black spaces, each being one centimeter long. By counting the number of these spaces, which disappear into the ureteral opening, the desired measurement is secured. An additional aid in making the diagnosis of concretions deposited in the renal pelvis may be had by the use of the ureteral catheter. This method is, however, seldom employed since the skiagraphy of renal and ureteral calculi has made such great advance.

The catheter is introduced until its tip rests in the renal pelvis; then sterile water is injected through the catheter into the renal pelvis. If this injection is followed by the appearance of blood, in the urine which has been taken from this kidney, this phenomenon points very strongly to the presence of calculi, whose movement as the result of the injected stream of water produced hemorrhage. If a wax-tipped ureteral catheter, after being withdrawn from the renal pelvis and ureter, shows scratches on its wax coating, absolute evidence is furnished of the existence of concretions. This method is not sufficiently to be relied upon to be employed as a routine measure (see page 430).

In deciding upon the patency of a ureter, either solid sounds or ureteral catheters, strengthened through the insertion of a metallic mandrin,

must be used. All these instruments should be well lubricated with glycerin before using. It must be remembered, however, that the mere fact that a catheter or a sound meets with resistance somewhere in the ureteral canal, does not prove the existence of some permanent obstruction. Very often the catheter is simply caught in a mucous fold, or the mucosa is, by virtue of some inflammation, swollen to such an extent as to impede the smooth progress of the catheter-tip. This is especially true for the vesical part of the ureter. In case the catheter does not

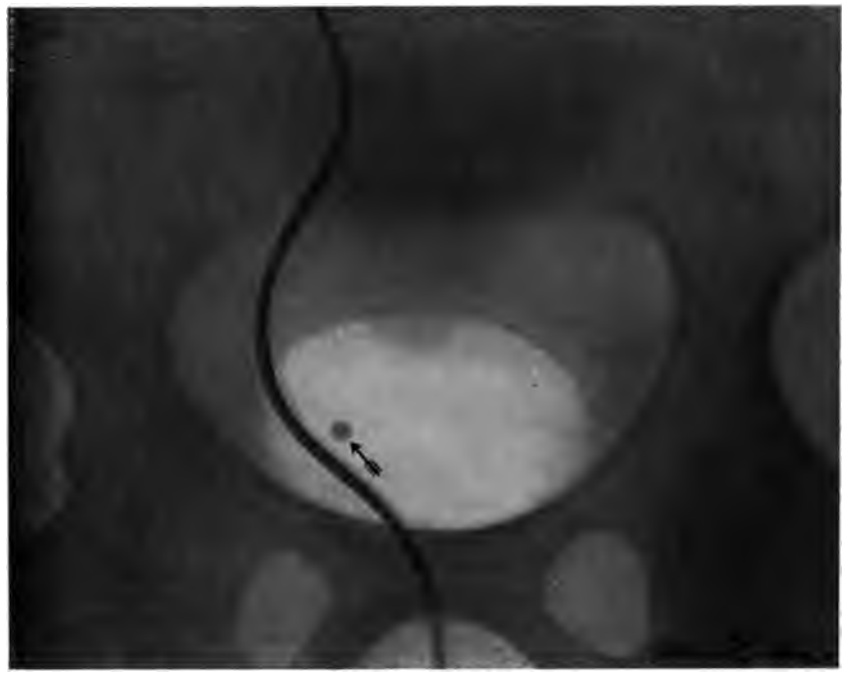


FIG. 566.—RADIOGRAPH OF SUSPECTED RENAL CALCULUS WITH SOUND IN URETER (E. Hurry Fenwick). The arrow points to a shadow which was shown to lie outside of the ureter, the latter being filled with a shadowgraph bougie. The shadow proved to be a patch in an atheromatous artery.

progress smoothly and warps, several methods can be employed in order to exclude obstruction due to a mucous fold or a swollen mucosa.

Glycerin is injected through the ureteral catheter, and then a thicker catheter is employed, the tip being repeatedly twisted around, so as to extricate it out of an interfering fold of mucosa; in case the ureteral opening should show signs of inflammation, a few drops of adrenalin solution are injected into the vesical end of the ureter, so as to cause the mucosa to contract and thus reduce the swelling.

The *diagnosis of a stricture of the ureter* can only be made if a thinner catheter or sound passes through the whole length of the ureter, after a larger instrument has failed to do so, and if the sound, after having passed through the region of apparently reduced lumen, gives the examining hand the distinct impression of being "engaged," *i. e.*, held or grasped by the stricture.

The diagnostic range of ureteral catheterization can be amplified by its combination with radiography (Fig. 566). A metallic sound (lead wire) or, better still, a catheter into which a metallic stylet is introduced into the ureter and renal pelvis, and an *x*-ray picture is taken while the catheterizing instrument is *in situ*, the shadow of the wire appearing in the *x*-ray picture.

The following information can thus be gleaned: The shadows of the wire mark the course of the ureter. In case the renal pelvis should be enlarged (dilated) the proximal end of the wire adjusts itself to the shape of the pelvis, outlining its size by curling up on the inner surface of the pelvis.

If small round shadows appear in the *x*-ray picture somewhere alongside the course of the ureter, it can be determined whether these shadows are produced by ureteral concretions or not.

Ureteral concretions will necessarily produce shadows that are in intimate relation to the shadow produced by the wire lying in the ureter. Other conditions which produce shadows, not in close relation to the sound, are calcified mesenteric lymph-nodes, phleboliths in the veins of the pelvis, areas of ossification in the ligaments of the pelvis (see page 5).

If the shadow of the wire leads directly into the shadowy outline of a tumor, the connection of this tumor with the kidney is established.

The collection of urine separately from each kidney renders it possible to determine which kidney or whether both are diseased, (*a*) by the microscopic and chemical analysis of the collected specimens; and (*b*) it furthermore enables the examiner to investigate the functional capacity of either kidney (see page 427).

METHODS OF DETERMINATION OF THE FUNCTIONAL ACTIVITY OF EACH KIDNEY.

CHROMOCYSTOSCOPY.

Drugs which stain the urine are brought into the circulation after being swallowed or by intramuscular injections. These drugs after a certain length of time (thirty minutes) color the urine. If this coloring is delayed in its appearance, or if the intensity of the coloring is lessened,

the kidney is considered to be below par. Methylene-blue can be given by mouth, and for intragluteal injections 20 c.c. of a 4 per cent. indigo-carmin[1] solution is used. The limitations of this method of chromocystoscopy are obvious. In the first place, we have no sliding scale that would enable us to draw reliable conclusions as to the time when the stain appears in the urine and the intensity of the coloring.

It is a matter of experience that normal kidneys show great variations as to both of these points, and that not infrequently diseased kidneys act very promptly. The only diagnostic point that can be gained by this method is, that if a stained urine is ejaculated from both ureteral openings, then we are dealing with two functionating kidneys, and, considering the rarity of a horseshoe kidney, we can say that two functionating kidneys are in all probability present.

FIG. 567.—APPARATUS FOR CRYOSCOPY (Fowler).

CRYOSCOPY.

Cryoscopy is the determination of the molecular concentration of the urine and blood by determining their respective freezing-point. The principle of this method is this: The richer a given substance is in regard to molecules, the lower will its freezing-point be below that

[1] The indigo-carmin test is the most frequently employed color test, and is of some value when combined with catheterization of the ureters.

of distilled water. The best apparatus to use is that of Boeckmann) Fig. 567).

Under normal conditions the urine is more concentrated as to molecules than the blood. If comparison between the freezing-point of the blood and of water show that this normal difference is diminished, then the functional capacity of the kidney, *i. e.*, its eliminative power, is diminished.

In other words, the question to be answered is whether one kidney will be sufficient to attend to the necessary elimination after the other has been removed.

Normally the human blood has a freezing-point of 0.56° C. lower than the freezing-point of distilled water. If this freezing-point of the blood sinks lower than the above-mentioned figure, then, according to those who recommend this method, we must conclude that there is retention, consequently an increase of the molecules in the blood, caused by an insufficient kidney action. *A normal freezing-point does not always indicate renal sufficiency. A high freezing-point may be found when the kidneys have a perfect functional capacity.*

If the deviation is more than 0.59° C. it is not advisable, as a rule, to extirpate a kidney. The freezing-point of the urine normally is from —1.3° to 2.0° below the freezing-point of water; a deviation beyond this limit proves the kidney to be unreliable, showing that the molecular concentration of the urine is unusually low. We must be sure that no polyuria exists in order that it may be of value. Extensive investigations have proved that this method is only reliable if the results are positive.

Phloridzin Test.

The administration of phloridzin leads, as a rule, to temporary glycosuria.[1] This glycosuria appears fifteen to thirty minutes after the administration of the drug, and disappears usually after three hours. After the urine has begun to flow freely through the ureteral catheter, twenty minims of a 1 per cent. phloridzin solution (freshly prepared) are given by intramuscular injection. The urine from each kidney is collected in separate bottles and tested for sugar every fifteen minutes. The glycosuria seldom lasts longer than two hours.

Delay in the appearance of the sugar, or small quantities of it, is supposed to point to an insufficiency of the kidney. The more renal

[1] Kapsammer was the first to show that the time of appearance of the sugar was of importance. Sugar can usually be detected in the urine of a normal individual in fifteen minutes.

parenchyma present, the more sugar is excreted, since the phloridzin, by irritating them, causes the withdrawal of sugar from the blood. This method is reliable only in a positive sense, because researches have proved that sometimes absolutely normal kidneys do not show the sugar reaction. It is of value when combined with ureteral catheterization. The employment of this method seems to involve a certain risk, as there are a few cases reported in which the administration of phloridzin was followed by hematuria or unusually prolonged glycosuria.

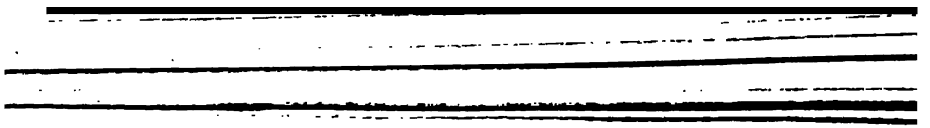
All of the previously enumerated methods have in common one serious drawback. They do not furnish us any clue as to whether an existing reduction in the functional capacity of a kidney is not a temporary condition due to the toxic substances brought into the circulation from the other, *i. e.*, diseased kidney.

Electric Conductivity of Urine.

An attempt has been recently made to estimate the functional capacity of a kidney by determining the fluctuations in the electric resistance of the urine produced by running indigo-carmin through the kidneys.

The principle is this, that first the electric conductivity of the urine is tested; immediately afterward indigo-carmin is injected into the gluteal muscles, and the electric conductivity is again tested half an hour after this administration. It is claimed that diseased kidneys show a decidedly decreased electric resistance after this application, and it is furthermore claimed that any decrease beyond twenty ohms classifies such a kidney as a surgically unreliable one.

Healthy kidneys show an increase in electric resistance varying up to ten ohms after the stain appears in the urine. Healthy kidneys, only temporarily reduced in their functional capacity, which reduction is proved by any of the above-mentioned methods, show nevertheless their normal possibilities by an increase of electric resistance after administration of indigo-carmin.



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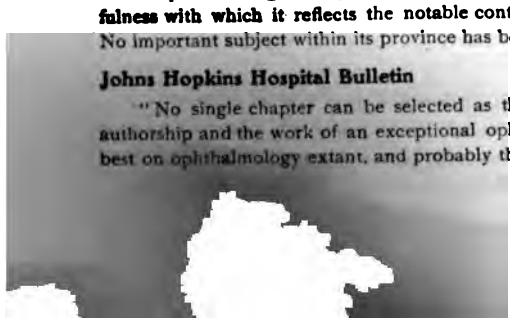

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